JAN 2 1912
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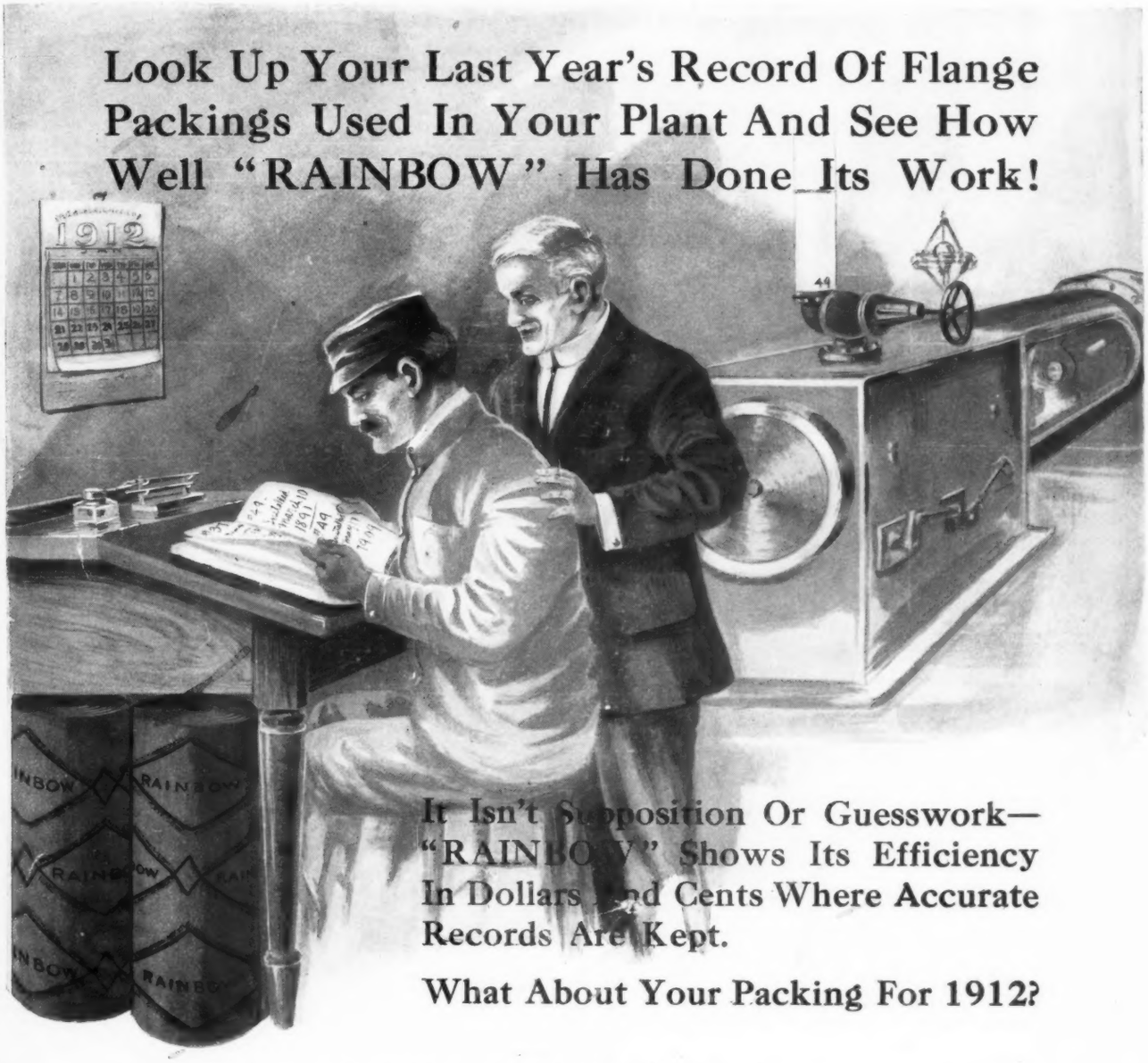
POWER

Volume 35, No. 1.
Issued Every Tuesday.
Hill Publishing Company.

NEW YORK, JANUARY 2, 1912.

Price, 5 cents.
Outline of Topics, 72.
Index to Advertisers, 61.

Look Up Your Last Year's Record Of Flange Packings Used In Your Plant And See How Well "RAINBOW" Has Done Its Work!



It Isn't Supposition Or Guesswork—"RAINBOW" Shows Its Efficiency In Dollars And Cents Where Accurate Records Are Kept.

What About Your Packing For 1912?

PEERLESS RUBBER MANUFACTURING COMPANY

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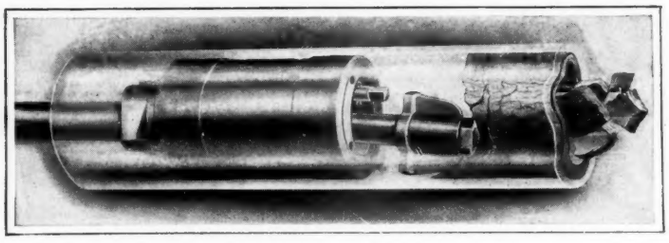


The Dean Removing Scale from the Tube of a Water Tube Boiler

Ten Years Ago

Ten years ago we wouldn't have dared tell you what we are going to tell you in the succeeding announcements.

Boiler owners and operators wouldn't have believed us.

Those were the days when boilers were physicked with compounds and never introduced to tube cleaners.

And if you stop to think you'll recall that those were the days of numerous explosions, of numerous blowouts and tube failures, of excessive fuel consumption.

Scale exacted a big toll from boiler owners.

And all because engineers didn't fight scale right.

But engineers are not doing their boiler cleaning as they used to.

They have come to see that periodical inspection and mechanical cleaning are the only cure for scale.

The Dean Boiler Tube Cleaner

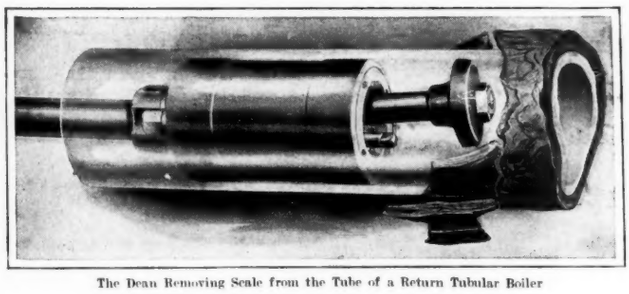
is the one positive and sure way of solving the scale problem.

The DEAN is a small engine, operated by steam or compressed air, which works a tiny vibrator at the rate of from 3,500 to 10,000 times a minute.

The movement of this vibrator sets up a series of vibrations in the tube, which jar the scale loose.

The DEAN cleans the tubes of fire tube or water tube boilers, cleaning 10 to 30 tubes an hour.

Let us send you one on trial.



The Dean Removing Scale from the Tube of a Return Tubular Boiler

Free Trial Offer

We'll loan you a Dean for free trial in one boiler. We won't hurry you with the test, force the cleaner on you, nor get sore if we don't effect a sale. We simply want you to see what a money-saving proposition we have. Then it's up to you to decide what to do with it

The Wm. B. Pierce Co.

Jewett Bldg., Buffalo, N. Y.

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KEYSTONE GREASE

KEYSTONE TRADE MARK REGISTERED U.S. PAT. OFF.

With Keystone Users Everywhere

—Out In The Breezy West—

There's absolutely no question as to what the Engineer from across the Mississippi thinks about Keystone Grease.

For the Westerner meets our Salesman with a free and easy dash and a hand shake that warms the cockles of the heart—

"How's my Quaker friend and when did you hit town?

"That Keystone Grease of yours sure is great stuff.

"Come up and have lunch and I'll tell you all about the new good things that I'm discovering about it every day.

"The longer I use it, the better I like it."

You'll find the same thing true too.

Try Keystone Grease—at our expense—and see if you don't.

Just fill out and return the coupon and we will send at once and absolutely without charge, a Can of Keystone Grease, a Grease Cup and an Engineer's Cap.
Why not mail the Coupon now?

KEYSTONE LUBRICATING CO.

Executive Offices and Works

21st, Clearfield and Lippincott Streets **Philadelphia, Pa.**

Branch offices and warehouses in the principal cities of the United States.
Agencies in the principal countries throughout the world.

No Connection With The Oil Trust

A SAMPLE FREE

KEYSTONE LUBRICATING COMPANY, Phila.

Please send us a large size sample of Keystone Grease, sufficient for testing purposes, and one Brass Grease Cup and Free Engineer's Cap. It is thoroughly understood that no charges whatsoever will be made for sample, cup or cap, and all express charges will be paid by you.

Name of bearing where sample will be tested . . . . . .
Its width . . . . . Combined horse power of engines . . . . . .
Tap size of cup . . . . . .
FIRM . . . . . .
Per . . . . . .
City . . . . . State . . . . . .
Size cap required. . . . . **CUT OUT THIS COUPON AND MAIL IT TO-DAY** Dept. B—1-2-12

Lunkenheimer

is a name well known in the engineering field.
It is synonymous with quality.

"DURO"

is a name synonymous with durability, and which when associated with Lunkenheimer and

Blow-Off Valves

is immediately recognized by engineers as the trade name of a valve without an equal.

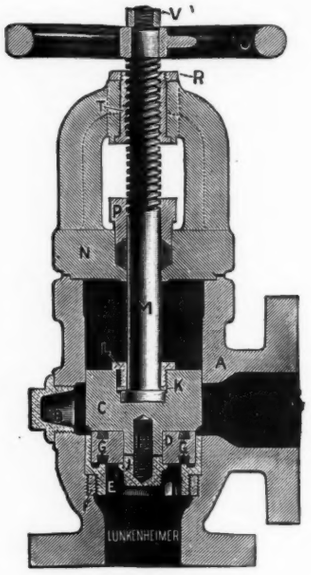


Fig. 897

Lunkenheimer "Duro" Blow-Off Valves

are guaranteed for 250 pounds working pressure. The body is made of cast iron having a tensile strength of 25,000 pounds per square inch, and the bronze used contains a high percentage of copper and tin.

One of the principal advantages in the design of these valves lies in the construction of the seat and disc, which provide self-cleansing seating surfaces so that any scale or grit lodging on the face of the seat will positively be washed off before the disc is firmly seated, thereby insuring a perfectly tight valve.

The disc is double seated and can be reversed or renewed when worn. The seat is also renewable, as are also all other parts of the valve subjected to wear.

Lunkenheimer "Duro" Blow-off Valves are made in sizes ranging from $1\frac{1}{4}$-inch to 3 inches inclusive.

Specify and insist upon securing genuine Lunkenheimer make. Do not accept substitutes,—they are never as good as the genuine.

"MOST supply houses sell them—yours CAN, if they DON'T or WON'T—tell US.

The Lunkenheimer Company

Largest manufacturers of High Grade Engineering Specialties in the World

General Offices and Works, CINCINNATI, OHIO, U.S.A.

NEW YORK	CHICAGO	LONDON, S. E.	BOSTON
64-68 Fulton Street	186 N. Dearborn Street	35 Great Dover Street	138 High Street

"How"
No. 3

How To Prevent Bagging Troubles

¶ Bagging of boiler tubes or plates is a serious thing—

¶ And if there happens to be any bagging in your boilers—

¶ You can rest assured you're going to have trouble immediately.

¶ Yet bagging is only another evil directly due to scale.

¶ Bagging will be prevented—

¶ *If* scale is not allowed to form—if the feed water is properly treated—

¶ If the water is analyzed by experienced specialists—to determine what scale forming elements it contains—

¶ And then the right kind of treatment, that will counteract these elements, is prepared.

¶ That is the logical, the right way, to tackle bagging. And the Dearborn Laboratory is *the* one to do this work for you.

¶ It is the only laboratory of its kind—analyzes over 8000 samples of feed water annually—and is in every way—knowledge, experience, facilities—best fitted to help you out of your boiler difficulties.

¶ Suppose you send us a gallon of your feed water, in a jug, bottle or any container so long as it's clean before you put in the water.

¶ We'll analyze it and then let you know exactly how much Dearborn Treatment, to fit *your* needs, will cost. Do this today.

Dearborn Drug & Chemical Works

Robert F. Carr, Pres.

General Offices, Laboratory and Works, Chicago
General Eastern Offices, 299 Broadway, New York

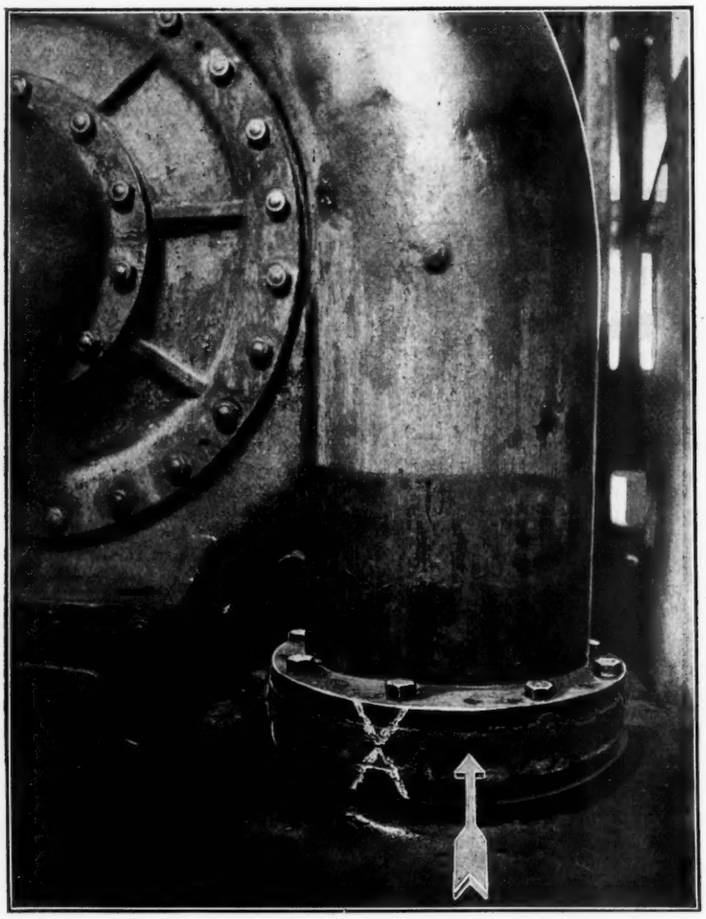
Branch Offices in Principal Cities

"How"
No. 4
Next Week

SMOOTH-ON Makes Difficult Repairs Easy

Here's a case where an eighteen inch flange was out of level—in fact the flanges didn't square up within 2½ inches.

The engineer was up against it—soft rubber gaskets didn't help him out any—but SMOOTH-ON helped him out just as it has helped out hundreds of engineers in all kinds of repair troubles. We are permitted to publish Mr. Witherells' letter referring to this SMOOTH-ON job and we believe it will interest you—here it is:



NEW YORK AND QUEENS ELECTRIC LIGHT AND POWER COMPANY

ASTORIA, N. Y., October 21, 1910.

SMOOTH-ON Manufacturing Company,
Jersey City, N. J.

About one year ago we installed a centrifugal pump and had great difficulty in making the necessary connections, owing to an 18″ pipe and flange projecting through the concrete floor (which was installed some five years ago), being out of level.

The pipe and pump flanges did not square up to within 2½″ (see cut), and both flanges were rigid.

We tried a bevel dutchman with a soft rubber gasket between each flange. This failed. Your Mr. Googins called and recommended SMOOTH-ON Iron Cement No. 1. The bolts and nuts were put in place and made fast, then SMOOTH-ON mixed to a very stiff putty was applied to the flanged faces until all open space between them was filled (see cut). This was allowed to harden. The expanding action of the SMOOTH-ON made the joint tight, and it is still tight.

A. WITHERELLS,
Supt. of Mfg.

No matter what kind of a repair it is that is causing you worry, before you go to any expense, try Smooth-On. You will find that it is just what you need. It is easy to apply and when it hardens it is part of the metal; that's why the leaks are stopped permanently.

Our Instruction Book No. 9 shows many different purposes for which Smooth-On can be used with great results—*it's free*—so write for a copy.

Smooth-On Mfg. Co.,

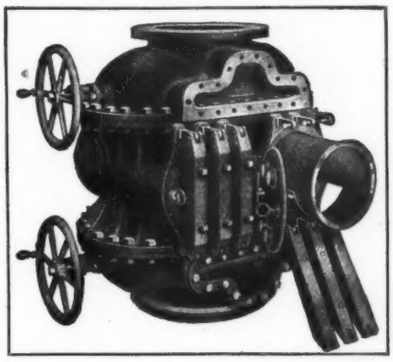
572-574 Communipaw Avenue
Jersey City, N. J., U. S. A.

Chicago Warehouse, 231 N. Jefferson Street
San Francisco Warehouse, 94 Market Street
English Branch, 8 White Street, Moorfields, London, E. C.

Trouble! Trouble!! Trouble!!!

THE REMEDY

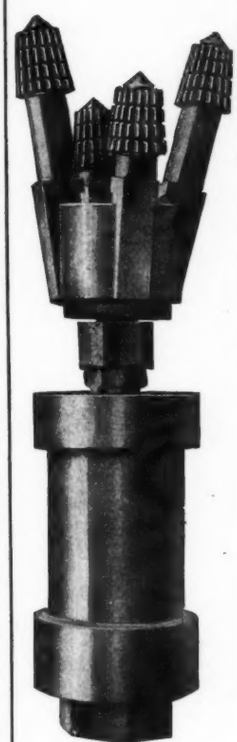
The **cleaning of Pumps, Valves, and Condensers** always comes at the **wrong** time. You put off this job just as long as you can but it **must be done** sometime. Have you ever thought that the **best way** to **avoid** this **loss** of time and operation is to **keep out these materials?** We have not only **thought** about it, **we have** the article which does the trick. It is a



Twin Strainer.

Place a **Twin Strainer** at any accessible point in the **suction** or **supply** line and this objectionable material **cannot reach your equipment.** Furthermore, it can be **cleaned** in a **few minutes** without difficulty and your **plant will be in continuous operation** while this is being done.

ELLIOTT COMPANY 6908 Susquehanna St. PITTSBURGH, PA.



Cyclone for Air or Steam

A New Year's Gift

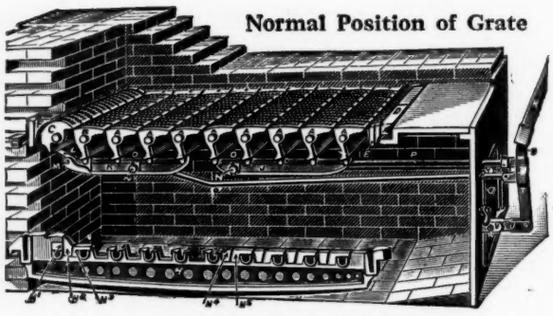
IS *always* appreciated. Sometimes we are unfortunate in making a selection, but little matters of that kind are overlooked, and the good intention of the donor is what appeals to us. If you have any *scale troubles* with your boilers, you can make no mistake in presenting them with a *Liberty Cleaner*. The boilers will show their gratitude by *increased efficiency, saving* of *fuel* and *materially cheapening* the cost of operation. If you are the responsible head of the business, it is certainly to your interest to *know* the *real condition* of your boilers, and sometines *reliable information* can only be obtained by *personal investigation.* If you think you are burning an *excessive* amount of fuel, see if it is not caused by *scale.* We will send you a *cleaner* that will locate the *scale,* if there is any, and if you find the tubes are clean and you have no use for the machine, send it back to us. We furnish cleaners for *all* types of boilers.

Let us send you our catalog.

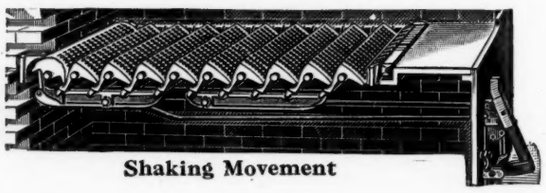
Liberty Manufacturing Company
6705 Susquehanna St., Pittsburgh, Pa.

Bull Dog Water Turbine

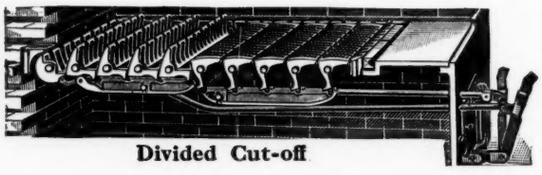
Perfect Combustion
High Grade Results
Low Grade Fuel



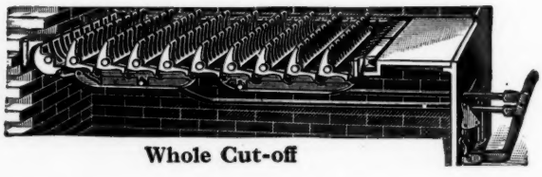
Normal Position of Grate



Shaking Movement



Divided Cut-off



Whole Cut-off

McClave Grates and Argand Blowers

Provide a fuel burning *system*.

This means reduction in cost of operation.

No waste of fuel.

Thorough Combustion.

Removal of fine ashes.

Cleaning uniformly.

Gets rid of clinkers without opening fire doors.

In the Hudson-Manhattan power plant the installation of our system permitted the use of No. 3 Buckwheat at 43 per cent. less cost than No. 1.

Ask For Catalog "G"

McClave-Brooks Company

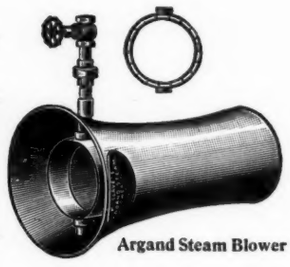
Scranton, Pa.

Branch Offices:

New York, 351 Fulton Bldg.
S. C. Smith, N. Y. Manager

Pittsburg, 1007 Empire Bldg.
Chas. N. Hays, Sales Agent.

Chicago, 706 Fisher Bldg.
F. G. Smith, Manager.



Argand Steam Blower

POWER

Vol. 35 NEW YORK, JANUARY 2, 1912 No. 1

What, ho! for the New Year.

Here she comes, and a banner year from every point of view, we warrant you.

To begin with, there are 366 days in this leap year of grace and exceptional opportunity, 1912. A good sign of full measure right from the go-off.

Now, then, what shall this year bring forth for you and yours?

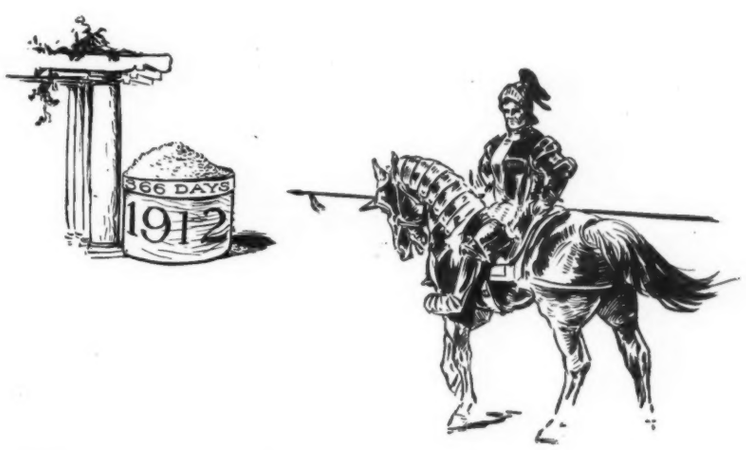
Much depends on you, of course; in fact, we are almost willing to say, everything does. Whether you profit much or little by your opportunities, it is up to you—and you alone. As has been said before, no one is going out of his way to boost your game.

These opportunities seem to grow more and more numerous each year.

* * *

Every year finds the means of education closer at hand and more easy to obtain. There is small excuse for a person being short on "learning," these days.

For the men in the cities there are the evening grammar, trade and technical classes of the public schools, the institutes and the colleges. For the men in the smaller places there are the correspondence schools, the National Association of Stationary Engineers and the Institute of Operating Engineers, and for every man there is POWER!



* * *

New plants are being built. This means that more positions are being created for suitable men.

This whole year of 1912 is one big, long opportunity for *you* to prove that you are too good for your present position.

If you really are worthy of a bigger and better position, and you try earnestly enough to secure one, sooner or later you must succeed.

Remember, the higher, the fewer, which is another way of saying there is plenty of room at the top.

* * *

It is a common custom every year at this time to foot up the page and strike a partial balance in the ledger of life. That's where the expression about turning over a new leaf comes from.

Last year, at this time and on this page, we said something about forming good habits and breaking up bad ones. All those who succeeded in knocking out even one bad habit or in forming one good one, certainly have a fine credit page to boast about this year. All those who did not, have a new and convenient opportunity to try it over again, RIGHT NOW. And this year, the latter should make out much better because they have had one year more of experience by which to benefit.

* * *

POWER wishes you good luck, success in your good ambitions and a regular old cornucopia of prosperity for 1912.

Power System of the Pacific Mills

The Pacific Mills represent several textile industries located in North Lawrence and South Lawrence, Mass., and Dover, N. H. They employ some 9000 operatives and manufacture principally worsted and all-wool dress goods, printed and dyed cotton, worsted and silk fabric, and an addition now being built at South Lawrence will be, when completed, the largest print works in the world.

The entire Pacific Mills contain about 142 acres of floor space, and operate 404,360 spindles, 10,468 looms and 48 printing machines. There are 181 engines and turbines of 30,000 horsepower; 165 boilers of 36,000 horsepower and waterwheels of 7500 horsepower. There are also 625 electric motors aggregating 17,700 horsepower.

The different departments consume 10,000,000 pounds of wool, 20,000,000 pounds of cotton and 85,000 tons of coal per year. The finished product of the printing department alone is about 2000 miles of printed cotton cloth per week.

Increase in the power demand, due to the installation of modern high-speed machinery and the realization of the fact that the old power apparatus was getting to the end of its useful life, led to the decision to build a central power plant which is one of the largest isolated steam-turbine stations in the world devoted entirely to the textile industry.

The design and supervision of the construction were assigned to Charles T. Main, and the plant was the subject of a paper presented by Fred A. Wallace, master mechanic of the Pacific Mills Corporation, to a recent meeting of the Boston Society of Civil Engineers, the Mechanical and Electrical Engineers cooperating. It is to this paper and to photographs and information furnished by Mr. Wallace, with the kind consent of Walter E. Parker, agent of the Pacific Mills, that we are indebted for the facts and illustrations here presented.

Notwithstanding the fact that in the operations of slashing, dyeing, printing, etc., all of the steam exhausted by the prime movers necessary to run an installation of this kind could be used, it was determined on account of space considerations to place the station at one extremity of the property, as shown upon the accompanying map, and to run it condensing. It is evident that more would be gained in economy of operation in one large central station and in the valuable space, light, cleanliness and indemnity from fire risk by displacing the old equipment and the belt drives by simple electrical transmission.

The new station is located on a 3½-acre lot adjacent to the main-line tracks of the Boston & Maine Railroad and it is within reach of the river for condensing water and about one-quarter of a mile from the upper mill. It sends current at 2300 volts to four centers of distribution, the farthest of which is over two-thirds of a mile away. The position of the power plant relative to the various properties is indicated in Fig. 2, although the farther mills are still more distant than the sketch indicates on account of the section containing the Atlantic Mills, which has been removed in the grouping shown.

The managers of the Pacific Mills, with 181 engines and turbines aggregating some 30,000 horsepower and 165 boilers of 36,000 horsepower, concluded to meet the conditions created by the growing disability of their older equipment and the increasing demand for power by the erection of a central turbine condensing station to distribute power electrically to the mills, some at a considerable distance.

This is the largest central station yet built for textile work. It is expected that the economies of aggregation will compensate for the loss of the use of the exhaust steam for dyeing, preparation, heating, etc.

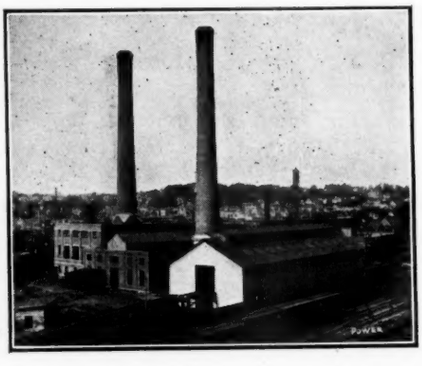


FIG. 1. POWER PLANT OF THE PACIFIC MILLS

A general view of the exterior of the station is afforded in Fig. 1, where the nearer building is the coal storage, the low central building with the monitor is the boiler room and the farther building is the turbine house.

THE BOILER ROOM

The boiler house is 140x87 feet and contains two rows of boilers with a 20-foot space between them for a firing floor, which is on a level with the yard and the turbine-room basement. The boilers are horizontal return-tubulars, 72 inches in diameter, and have 20-foot tubes.

The tubes are 3½ inches in diameter and the total heating surface of each boiler is about 1900 square feet; they are set in batteries of four boilers each, 12 boilers being on each side of the firing floor.

The shells are $\frac{13}{32}$ inch thick with quadruple-riveted joints, and by the Massachusetts rating can carry 160 pounds; they are set 30 inches from the grate, which has an area of 36 square feet. The shells are suspended by brackets and rods from an overhead structure which is carried on cast-iron columns so that none of the load comes on the setting. A large skylight with louvers in the sides extends the entire length of the room over the firing floor, thus giving excellent light and ventilation. The boilers are hand fired and 12 per cent. CO_2, 7 per cent. O and 0 per cent. CO are obtained as a usual result. No economizer is used and the flue gases escape to the chimney at 475 degrees. The firing floor is of vitrified brick on a concrete base. The toilet rooms contain modern shower baths with hot and cold water and individual lockers.

CHIMNEYS

Each group of 12 boilers has a chimney, 9 feet inside diameter by 200 feet high, built of common red brick on a concrete foundation carried on piles. Each chimney is constructed with a separate red-brick core wall and with a cast-iron cap at the top covering both the core and the shell; the portion for the core is separate from that of the shell so that they may move independently. Collector points for the lightning rods are attached to this cap.

The 12 boilers are connected to the two chimneys by a sheet-iron flue 6x10½ feet, having a double damper which is controlled by a regulator and maintains the boiler pressure constant within one pound. No provision is made for artificial draft.

PIPING

Steam is taken from the boilers by a 4-inch pipe and passes through superheaters set in the rear of the combustion chamber. The 4-inch pipes connect to a 10-inch main steam header from which

the steam passes to the different turbines and auxiliaries. The piping has been so proportioned as to get an average flow of about 7900 feet per minute. All piping is of the 250-pound standard, having the Van Stone type of joint and cast-steel fittings. All valves are steel body and bronze, fitted with outside screws. Two stop valves, two blowoff valves and two safety valves are fitted to each boiler.

Feed water is taken by duplex pumps from the condenser discharge at about 75 degrees Fahrenheit and passed through an exhaust-steam heater which raises the temperature to about 200 degrees Fahrenheit. This heater condenses the exhaust steam from the feed pumps, condenser pumps and engines and the engines which drive the exciter and a 75-kilowatt alternator.

Both the steam and the feed-water piping are so arranged that practically any portion of the plant may be isolated in case of accident or when it is desired to conduct a test. An ingenious arrangement for supporting the main 10-inch steam header consists of a steel yardarm held at the ceiling and carrying weights to balance the load of the pipe and the fittings. The piping was installed in place, with all its fittings, valves and flanges, but it was not connected to the boilers. The weights were moved to balance the entire system, and when adjusted the branches were bolted to the boilers, the entire line being supported without any strain. An excellent idea of the appearance of the boiler-room interior is given by Fig. 3.

Turbine Room

The turbine room is 126x79 feet, with a basement of the same size, and contains two 3850-kilowatt and two 750-kilowatt horizontal reaction steam turbines with jet condensers; two motor-driven exciter sets, one steam-driven exciter set and one 75-kilowatt engine-driven alternator with exciter. The turbines all run at 1800 revolutions per minute, with 150 pounds boiler pressure, 125 degrees superheat and 27 to 28 inches of vacuum.

The basement extends under the turbine room, is 14 feet high and is well lighted and ventilated. It contains all the boiler-feed pumps, condenser apparatus, fire pumps, heaters, etc.

Below the basement is a cistern 105 feet long, 10 feet wide and 20 feet deep which is connected by a 48-inch penstock to the river, which is about 1000 feet distant. This well supplies water for condensing and other uses about the station. One motor-driven centrifugal pump furnishes water under pressure for general purposes. The turbine-room basement floor is of concrete laid directly on the earth; the trenches for pipes, etc., have cast-iron covers.

The floor of the turbine room proper is of reinforced-concrete slabs on steel beams, which are supported independently of the turbine foundations, with a surface of red tiles about 9 inches square. The toilets for the engineers are similar to those of the boiler room and contain individual metal lockers and shower baths.

The condenser water, after passing the jet condensers, is returned to the river through a 48-inch penstock, having been raised in temperature some 15 or 20 degrees. The temperature of the river is but little above 32 degrees in the winter and reaches a maximum of 85 degrees in the summer.

The turbo-generators are cooled by air supplied through a shaft extending above the roof next to the chimney. In the shaft are 12 bags, each 26 feet long and 22 inches in diameter, made of cotton cloth of a weave suitable to admit air freely and yet to filter out the dust. The bags are cleaned every three months and about six quarts of material are collected.

All alternating current in the plant is generated three-phase, 60-cycle and 2300 volts, and is distributed in large blocks to the various groups of mills where a subdivision is made into smaller feeders. The major distributing mains are indicated in Fig. 2. The large power feeders to the upper and lower mills are really tie lines between stations, as one of these already has generators installed and the other will have in the future. The output of each generator is measured by an integrating wattmeter so that the total energy generated is known. The power sent to each group of mills is known, as each feeder circuit has its integrating meters. The power used for

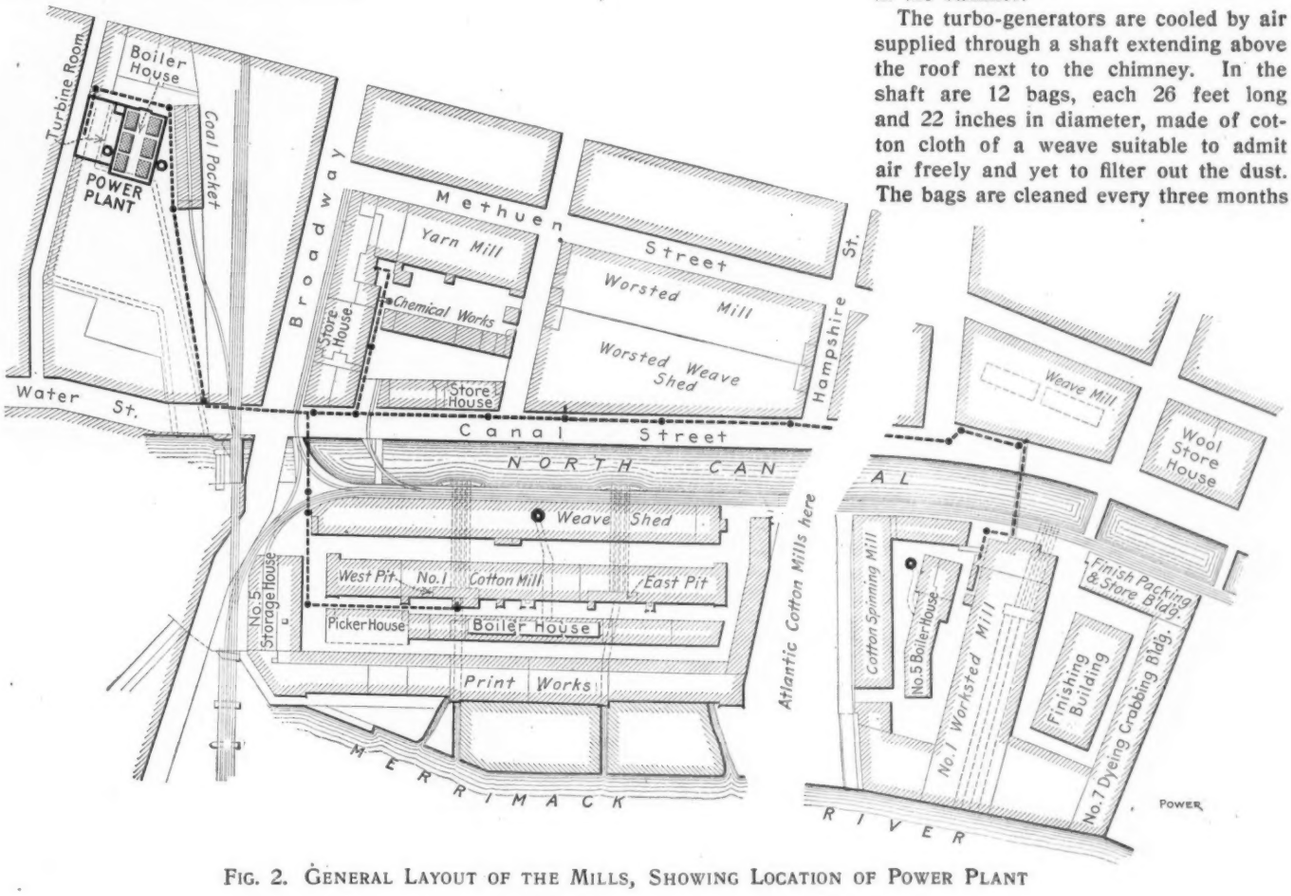


FIG. 2. GENERAL LAYOUT OF THE MILLS, SHOWING LOCATION OF POWER PLANT

driving the motor exciters, coal-handling apparatus, pumping, lights, etc., about the station is also metered. Each circuit is equipped with indicating meters so that the instantaneous load and current may be obtained.

Coal Storage and Handling

The coal is stored in a concrete pocket which is reached by a trestle from the Boston & Maine tracks. It is 210x52 feet and holds 5000 tons, with a storage depth of 20 feet. Cars are pushed up this trestle and dumped either into a main or an auxiliary pocket. The floor of the main pocket is 10 feet below the yard level and that of the auxiliary pocket is at the yard level so that coal may be taken from the auxiliary by automobiles if any accident should happen to the regular coal conveyer. A 6-inch pipe from the fire system is connected to the bottom of the coal storage so that in case of fire the whole area can be flooded as a last resort.

The coal-conveying system is a monorail grab bucket traveling at about 400 feet per minute and carrying 2000 pounds; the length of the average haul is about 350 feet. The working capacity of the bucket is about 12 tons per hour, allowing for weighing each load. A view of the conveyer and of the overhead track between the coal storage and the boiler rooms is shown in Fig. 5. One man handles all the coal at a cost of less than 2 cents per ton, including labor, repairs, supplies and electric current.

The load factor of the station is practically 33⅓ per cent. and, although the load is quite constant for 5⅙ hours in the morning and 5 hours in the afternoon, it starts and stops very abruptly, which makes it difficult to manage the furnace fires economically at those times.

All fires are banked at night except those required to run on overtime work or on the regular lighting circuits. The ashes are weighed before being taken from the boiler house and the percentage of ash is entered on the weekly report. Every carload of coal is sampled and a chemical analysis made for fixed carbon, volatile, ash, moisture and B.t.u.; this record is studied carefully in its relation to power-house results. The fires are cleaned at night by the night shift and the ashes are wheeled in barrels to the ashpile outside the building; they are sold for filling. At present four firemen and a boss fireman are on day duty, each fireman firing four 190-horsepower boilers. Three firemen are on duty during the night, two to clean the fires of 14 boilers, the third cleaning two boilers and being responsible for the station.

The help for the turbine room consists of the chief engineer, who has other duties outside the station, two operating men, one oiler for auxiliary apparatus and one cleaner, who is also a spare fireman.

The acceptance test of the turbines showed the following results with 150 pounds boiler pressure, 125 degrees superheat, 28 inches vacuum with barometer at 30 inches and condensing water at 70 degrees:

Load, Per Cent.	3850-kilowatt Unit	750-kilowatt Unit
50	17.83	.....
75	15.5	18.92
100	15.4	17.84
125	15.46	16.63
140	15.84	.....

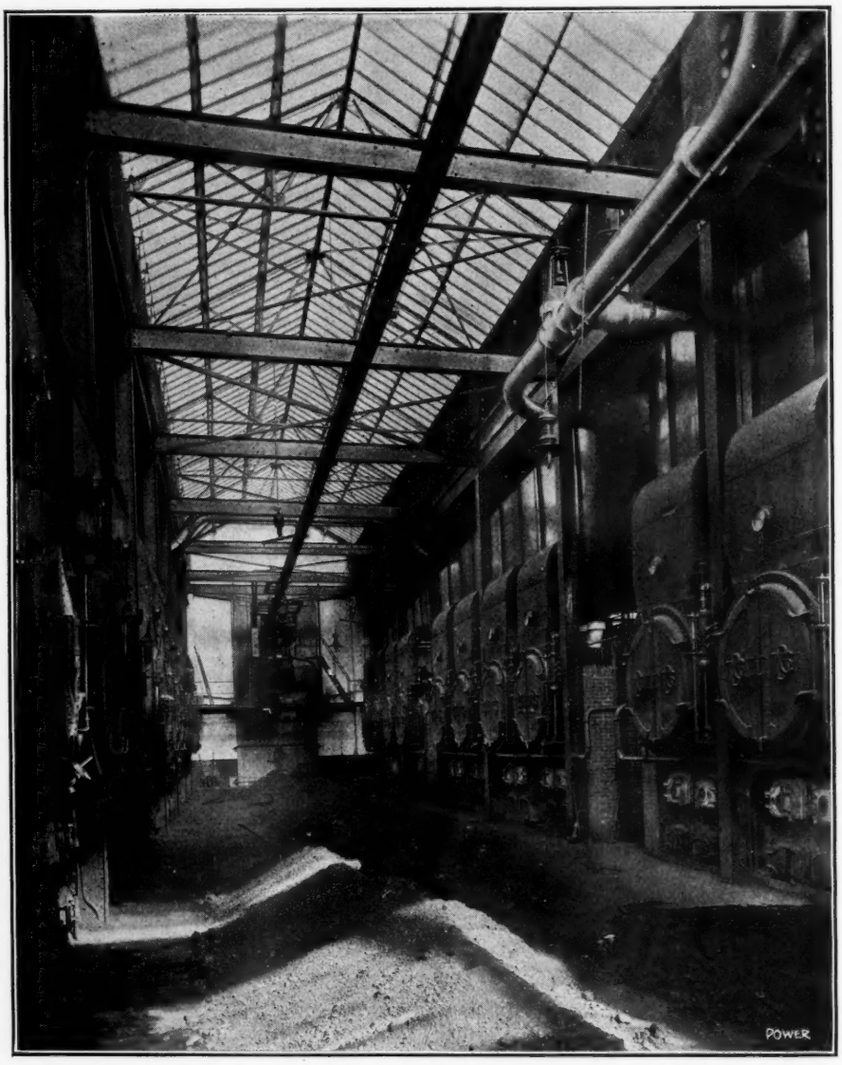


Fig. 3. The Boiler Room

The auxiliaries, including the condensers and feed pumps, use about 12 per cent. as much steam as the main unit. This test was made with the 3250-kilowatt turbine delivering 3810 kilowatts. Two condenser pumps, one feed pump and the Holly drip system were the auxiliaries which required the 12 per cent. The cost for operating an average week on 3600 kilowatts under the conditions which have obtained during the past year are as follows:

Turbine-room labor, five men and superintendence	$99.85
Boiler-room labor, eight men	99.15
Fuel, $4.25 per long ton in pocket	880
Oil, waste, supplies and repairs	37.05
Total operating expenses per week	1116.05

During the week 204,780 kilowatt-hours are generated, giving a cost per kilowatt-hour of 0.545 cent. In a few months the load will be increased to about 6100 kilowatts, thus giving a weekly output of approximately 340,000 kilowatt-hours. The two large turbines will then be run, leaving the two smaller ones as spares. To operate the station under these conditions will cost:

Turbine-room labor, five men and superintendence	$99.85
Boiler-room labor, nine men	108.95
Fuel, $4.25 per long ton in pocket	1483.25
Repairs and supplies	58.60
Total operating cost per week	$1750.65
Operating cost per kilowatt-hour	0.515 cent

The station as it now stands, with its 8000-kilowatt normal capacity of generators, cost, with the land and everything up to and including the switch-

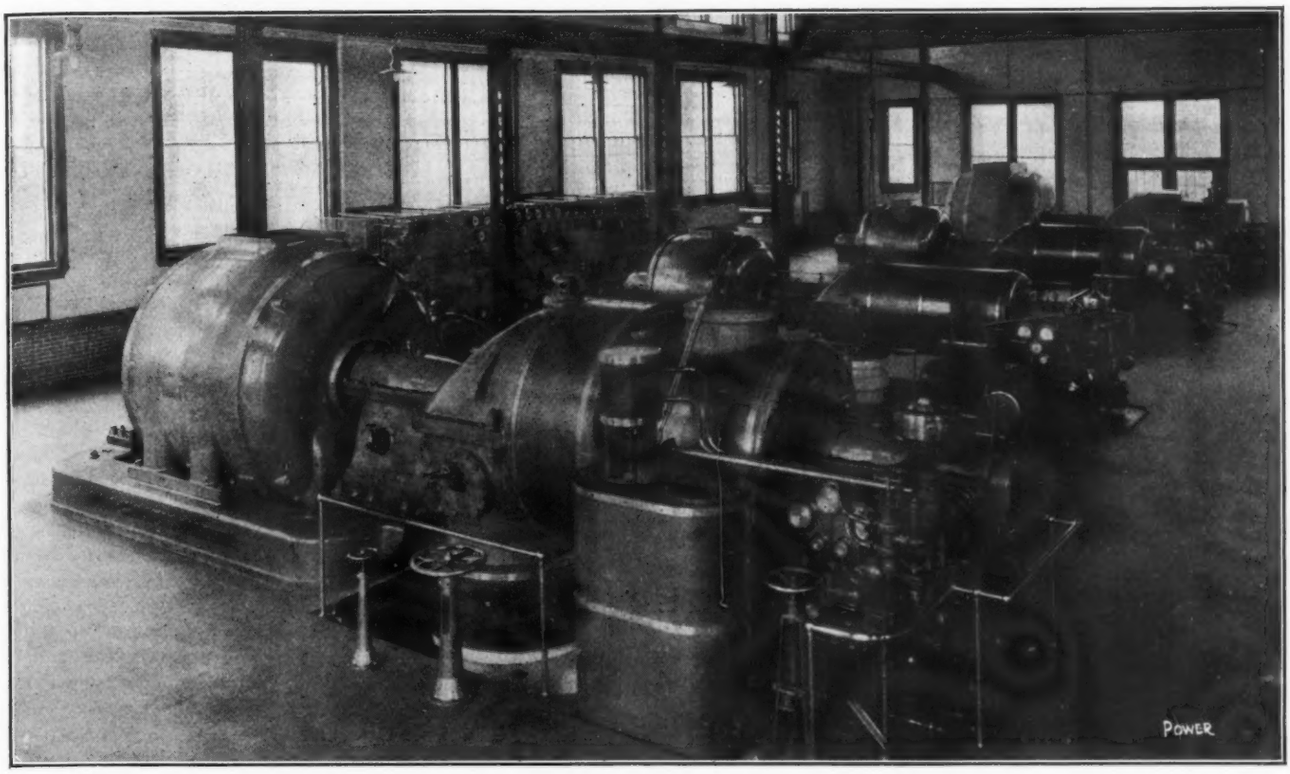


FIG. 4. THE GENERATING ROOM WITH ITS FOUR TURBINE UNITS

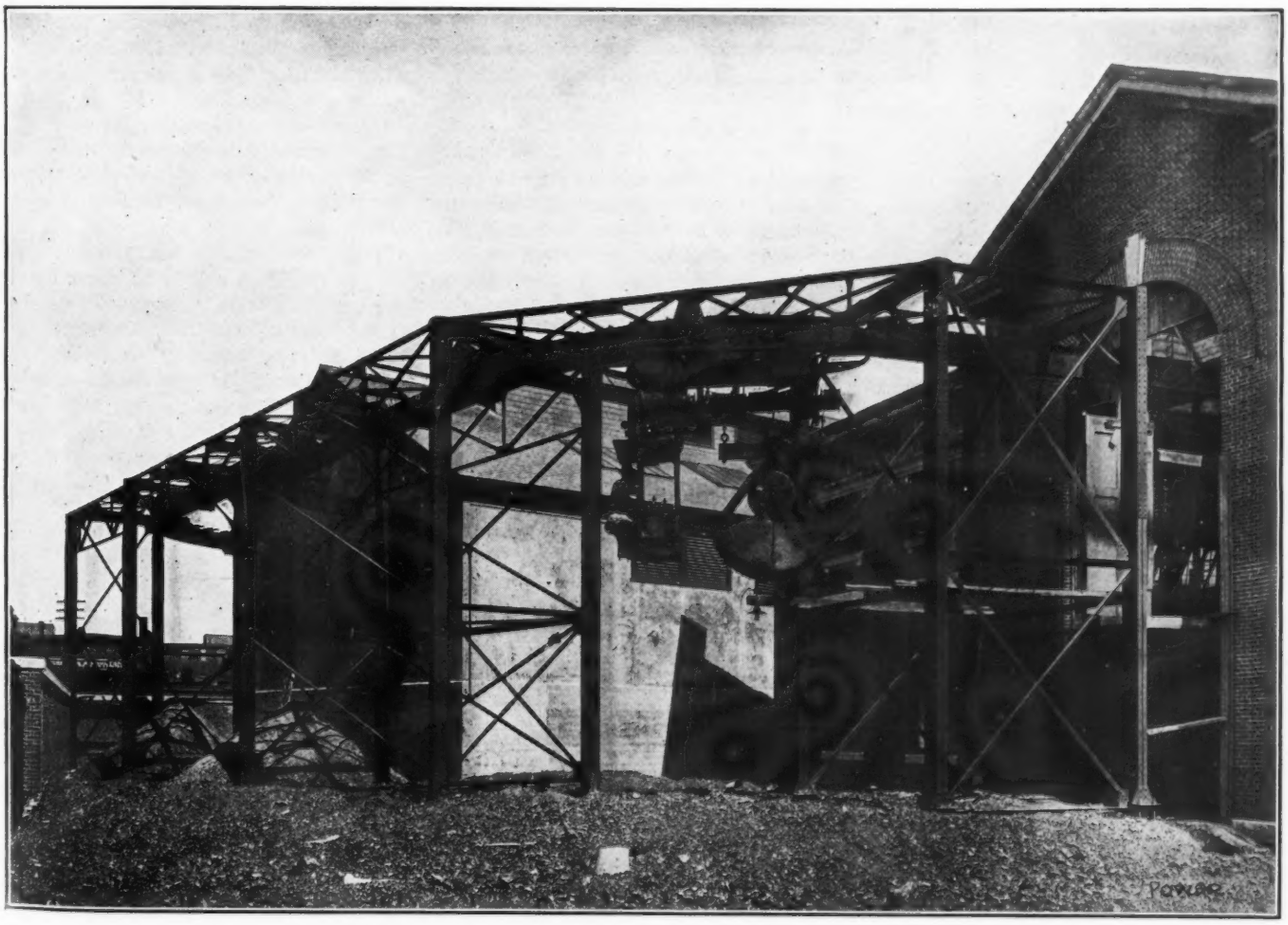


FIG. 5. MONORAIL GRAB BUCKET OF COAL-CONVEYING SYSTEM

board, a little less than $90 per kilowatt. Taking the fixed charges on this sum at 11 per cent., they become $79,200 per year, or $1523.08 per week. With the station generating 340,000 kilowatt-hours per week, the fixed charges will be 0.448 cent per kilowatt-hour.

Thus the total cost per kilowatt-hour at the switchboard for the 6100-kilowatt load on the plant will be

$$0.515 + 0.448 = 0.963 \textit{ cent}$$

The same figures, if this plant should be operated at its full capacity of 8000 kilowatts, would be 0.841 cent for the operating conditions of 6100 kilowatts; the cost is divided as follows:

	Per Cent.
Labor	6.4
Fuel	45.5
Repairs and supplies	1.8
Fixed charges	46.3

The principal objects in view in the design and operation of this station have been simplicity and reliability, and these have been obtained. Many of the requirements which are supposed to make for refinement and efficiency have been omitted, particularly in the boiler room, where simplicity was especially desired and was obtained as indicated by the photograph.

Deterioration of Coal in Storage*

By H. C. Porter and F. K. Ovitz

The tests showed that coal does not deteriorate, when exposed for a considerable time to the weather, nearly as much as is generally supposed. Also under-water storage has practically no detrimental effect upon coal, except for increasing the moisture.

Spontaneous heating is also discussed and suggestions given for preventing it.

*Presented at a joint meeting of the New York section, American Chemical Society, the American Electrochemical Society, and the Society of Chemical Industry.

Not many years ago, coal was commonly regarded as extremely unstable. E. C. Pechin, in 1872, speaking before the American Institute of Mining Engineers, said: "Coal suffers materially by storage; especially in the case of bituminous and semibituminous coals, an exposure of only two weeks causing a loss of carbon to the extent of 10 to 25 per cent." Similar views have been held in much more recent times; for example, in a paper before the United States Naval Institute in 1906 the statement was made: "The pressure of the weight of coal causes gases to be evolved; these gases constitute the chief and only value of the coal in that they furnish the heat units. It is claimed that if a ton of fine bituminous coal be spread out on a concrete pavement in the open air in the vicinity of Key West, Fla., for one year, it will lose all its calorific properties."

In 1907, a German gas-works engineer claimed to have found that moist fine coal sustained an average loss per week of 1.7 per cent. Other statements like these are to be found in recent literature, but probably the great majority of chemists and engineers today hold no such exaggerated ideas. There is, however, a well defined suspicion in the minds of many that sufficient loss of volatile matter and deterioration by oxidation does occur in coal to be of industrial importance; and for that reason the investigations herein described were undertaken by the Bureau of Mines to determine accurately the extent of the deterioration in different kinds of coals.

Deterioration by Oxidation

First, a study was made in the laboratory of the loss of volatile matter from crushed coal during storage. A number of samples (20 lb. each) representing a variety of types from widely separated fields, were broken to about ½-in. size and immediately placed in glass bottles while in the mine. At the laboratory the accumulated gas was withdrawn and a free continuous escape of the volatile products was permitted at atmospheric pressure and temperature. The results of these experiments have been published in technical paper No. 2 of the Bureau of Mines, entitled "The Escape of Gas from Coal," and will therefore not be given here in detail. Suffice it to say that while several coals evolved methane in large volumes, especially in the early period after mining, the coal suffered in one year a maximum loss in calorific value from this cause of but 0.16 per cent.

At the instance of the Navy Department, however—which is a purchaser of coal to the extent of two or three million dollars annually, and stores large quantities in warm climates for long periods of time—more elaborate tests were undertaken to determine the total loss possible in high-grade coal by weathering. The extent of the saving to be accomplished by water submergence as compared to open-air storage was a point to be settled, and there had also arisen the question as to whether salt water possessed any peculiar advantage over fresh water for this purpose.

The tests conducted by this department were carried out as follows: Four kinds of coal were chosen—New River on account of its extensive use by the navy; Pocahontas as a steaming and coking coal used extensively in the East, and as being also the principal fuel used in the Panama Canal work; Pittsburg coal as a type of rich coking and gas coal, and Sheridan, Wyoming, sub-bituminous or "black lignite"—a type much used in the West. With the New River coal, 50-lb. portions were made up out of one large lot, which had been crushed to ½-in. size and well mixed. These portions, confined in perforated wooden boxes, were submerged under sea water at three navy yards, differing widely from each other in climate conditions, and 300-lb. portions from the same original lot were exposed to the open air, both out of doors and indoors, at the same places.

The Pocahontas coal was tested only at one point, the Isthmus of Panama, the run-of-mine coal being placed in a 120-ton pile, exposed to the weather. Pittsburg coal was stored as run-of-mine in open outdoor bins of 5 tons capacity, at Ann Arbor, Mich., also in 300-lb. barrels submerged under fresh water. The Wyoming sub-bituminous was stored at Sheridan, both as run-of-mine and slack in outdoor bins, holding three to six tons each.

Every test portion was sampled each time in duplicate and in all cases except the outdoor pile at Panama and the 300-lb. open-air piles of New River coal, the sampling was done by rehandling the entire amount. In the excepted cases mentioned it was not thought fair to disturb the entire lot, and therefore at Panama a vertical section of 10 tons only was removed each time (eight samples being taken from the 10-ton section), while in the case of the outdoor lots at the navy yards a number of small portions, well distributed, were taken from each pile, mixed, and quartered down. Small lots and a fine division were conditions purposely adopted with the New River coal so as to make the tests of maximum severity.

Moisture, ash, sulphur and calorific-value determinations were made on each sample, the latter by means of the Mahler bomb calorimeter and a carefully calibrated Beckman thermometer. The calorimetric work on all except the Sheridan tests was done throughout by one man and with the name instru-

ment. Furthermore, all the calorific values in the tables were calculated to a comparable unit basis, that of the actual coal substance free of moisture, sulphur and corrected ash.

Results of Tests

The results show in the case of the New River coal less than 1 per cent. loss of calorific value in one year by weathering in the open. There was practically no loss in the submerged samples and fresh water seemed to preserve the qualities of the coal as well as salt water. There was almost no slacking of lump in the run-of-mine samples and the crushed coal in all cases deteriorated more rapidly than the run-of-mine.

The Pocahontas run-of-mine in a 120-ton pile on the Isthmus of Panama during one year's outdoor weathering lost less than 0.4 per cent. in heating value, and suffered little or no physical deterioration of lumps.

The Pittsburg gas coal during six months' outdoor exposure suffered no loss whatever of calorific value, measurable by the calorimetric method used, not even in the upper layer of the bins.

The Wyoming coal lost as much as 5.3 per cent. in one of the bins during two years and nine months; 3.5 per cent. of which was lost in the first three months. There was bad slacking and crumbling of the lumps on the surface of the piles, but where the surface was fully exposed to the weather this slacking did not penetrate more than 12 to 18 in. in the whole period.

No outdoor-weathering tests have been made by the bureau on Illinois coal. Thorough tests, however, on this kind of coal have been reported by Prof. Parr, of the University of Illinois, and by A. Bement, of Chicago, both of whom find from 1 to 3 per cent. calorific loss in a year by weathering. Mr. Bement reports a slacking of lumps (in tests on small samples) of over 80 per cent. in one case and about 12 per cent. in another. It is probable that in this case, as with the Wyoming test, the slacking in a large pile would not penetrate far from the surface.

Storage under water unquestionably preserves the heating value and the physical strength of coal, but it necessitates firing wet coal, and therefore means evaporating an amount of moisture varying from 1 to 15 per cent., according to the kind of coal. This factor is an important drawback to under-water storage with coals such as Illinois and Wyoming, which mechanically retain 5 to 15 per cent. of water after draining; but in the case of the high-grade Eastern coals, if firemen are permitted, as is ordinarily the case, to wet down their coal before firing, then the addition during storage of the 2 or 3 per cent. moisture which these coals retain would be of little consequence. Submergence storage is an absolute preventative of spontaneous combustion, and on that account alone its use may be justified with some coals, but merely for the sake of the saving to be secured by avoidance of weathering there does not seem to be good ground for its use.

Spontaneous Combustion

Losses in coal due to spontaneous heating are a much more serious matter. Oxidation begins at ordinary temperatures in any coal, attacking the surfaces of the particles and thus slowly developing heat. In a small mass of coal this slowly developed heat is readily dissipated by radiation, with no rise in temperature. If radiation is restricted, however, as in a large pile densely packed, the temperature slowly rises. Now, the curve of oxidation rate plotted against temperature, rises with great rapidity, and when the storage conditions are such as to allow a certain point (near 100 deg. C.) to be passed, the rate of oxidation is great enough ordinarily so that the heat developed over-balances the heat radiated and the temperature will rise to the ignition point if the air supply is adequate. The importance therefore can be seen of guarding against even moderate heating in the coal either from internal spontaneous causes or by radiation from external sources. Increased loss of heating value and of volatile matter occurs at moderately increased temperatures even though the ignition point is not reached.

The amount of surface exposed to oxidation in a given mass depends on the size of the particles and increases very rapidly as the fineness approaches that of dust. Dust therefore is dangerous in a coal pile, particularly if it is mixed with larger-sized coal which forms air passages to the interior. Spontaneous combustion is brought about by slow oxidation in an air supply sufficient to support the oxidation but insufficient to carry away all the heat formed. There is a wide variation among coals in friability. In comparative rattler tests under certain standard conditions, Pocahontas, New River and Cambria County coals produced nearly twice as much dust (through a ⅛-in. screen) as a sample from the Pittsburg seam. This is a large factor in spontaneous combustion. Mixed lump and fine (run-of-mine) with a large percentage of dust, and piled so as to admit to the interior a limited supply of air, make ideal conditions for spontaneous heating.

High volatile matter does not of itself increase the liability to spontaneous heating. A recent circular letter of inquiry on spontaneous combustion sent by the Bureau of Mines to more than 2000 large coal consumers in the United States has brought 1200 replies, of which 260 report instances of spontaneous combustion, 220 of them naming the coal. Of these 220, ninety-five were with semi-bituminous, low-volatile coals of the Appalachian region, and 55 with Western and Middle Western coals. This result shows at least no falling behind on the part of the "smokeless" coals and no cause for placing special confidence in these coals for safety in storage.

A serious fire in cinder filling under a manufacturing plant in Pittsburg was recently investigated and all the evidence pointed to spontaneous combustion as the cause, induced by external heat radiated from a furnace. The cinders contained 40 per cent. carbon. A similar fire occurred two years ago in cinder filling under a smelting plant on Staten Island in which the cinders contained 33 per cent. carbon; damage amounting to $20,000 was done. The cause was not definitely determined, but from the reports of the insurance adjusters spontaneous heating appears to be the most plausible explanation. The volatile matter in the material could not have been a factor in these cases.

Pocahontas coal gives considerable trouble with spontaneous fires in the large storage piles at Panama. It is reported also by several large byproduct-coke concerns to be more troublesome in this respect than their high-volatile gas coals. The high-volatile coals of the West are, to be sure, usually very liable to spontaneous heating, but they owe this property to the chemical nature of the substances which compose the coal rather than to the amount of volatile matter.

Moisture and Sulphur Influences

The influence of moisture and that of sulphur upon spontaneous heating of coal are questions much discussed, not very much actually investigated, and certainly not yet settled. Some claim that in the laboratory, dry coal oxidizes more rapidly than moist, but the weight of opinion among practical users of coal is that moisture promotes spontaneous heating. The observation by the Bureau of Mines of many actual cases has not developed any instances where moisture could be proved to have had such an effect. Sulphur, on the other hand, has been shown by these investigations to have, in most cases, only a minor influence. In a number of actual cases, samples of the heated coal from areas where the heat was greatest have been analyzed, both for the total sulphur and that in the sulphate form, and the unoxidized sulphur was in no case less than 75 per cent. of the average total sulphur in the original; in other words, not more than one-quarter of the total sulphur entered into any heat-producing reaction. The possibility remains, however, that all of the sulphur which was oxidized was concentrated in one pocket of moist, flaky pyrites, and thus sufficient heat was developed in one spot

to act as an igniter. On the other hand, a Boston company, using Dominion (Nova Scotia) coal containing 3 to 4 per cent. sulphur, has had much trouble with spontaneous fires in storage, but a number of samples taken by the bureau from exposed piles of this coal in which heating had occurred showed that 90 per cent. of the sulphur was still unoxidized. Experiments in the laboratory, by passing air over coal at 120 deg. C., have developed enough heat to ignite the coal and no change was found in the form of the sulphur. While not entirely conclusive, these results point to a very minor contribution, if any, on the part of sulphur to spontaneous heating in coal.

Freshly mined coal and even fresh surfaces exposed by crushing lump coal exhibit a remarkable avidity for oxygen, but after a time they become coated with oxidized material, so that the action of the air becomes less vigorous. It is found in practice that if coal which has been stored for six weeks or two months and has already become somewhat heated, be rehandled and thoroughly cooled by the air, spontaneous heating rarely begins again. A large power plant in New York crushes its coal to pass through a 4-in. screen immediately after unloading from the barges, the fine coal and dust (50 per cent. or more) being left in the coal to be stored. This freshly crushed coal is elevated to iron hopper-shaped bunkers directly over the boilers and the air temperature in these often reaches 100 deg. F. As the coal hangs on the sloping sides sometimes three or four months at a time, it seems hardly surprising that some of the bunkers are on fire practically all of the time.

Safety Precautions for Coal Storage

With full appreciation of the fact that any or all of the following recommendations may under certain conditions be found impracticable, they are offered as being advisable precautions for safety in storing coal whenever their use does not involve an unreasonable expense:

1. Do not pile over 12 ft. deep or so that any point in the interior will be over 10 ft. from an air-cooled surface.
2. If possible, store only lump coal.
3. Keep the dust out as much as possible; therefore reduce the handling to a minimum.
4. Pile so that the lump and fine coal are distributed as evenly as possible; not, as is often done, allowing lumps to roll down from a peak and form air passages at the bottom.
5. Rehandle and screen after two months.
6. Keep away external sources of heat even though they are moderate in degree.
7. Allow six weeks' "seasoning" after mining before storing.
8. Avoid alternate wetting and drying.
9. Avoid admission of air to the interior of the pile through interstices around foreign objects, such as timbers or irregular brickwork; also, through porous bottoms, such as coarse cinders.
10. Do not try to ventilate by pipes as more harm than good is often done.

Status of the Small Steam Turbine*

By W. J. A. London

The paper points out some of the uses to which small turbines are adapted, compares electric, reciprocating-engine and turbine drives for these purposes; shows that the water rate of small steam turbines can be improved, but at the expense of greater weight, floor space and first cost; suggests the use of Napier's formula for a simple determination of the steam rate.

*Presented at the New Haven meeting of the American Society of Mechanical Engineers, by Chief Engineer London, of the Terry Steam Turbine Company.

The new uses for the turbine and the fact that all builders of small turbines are turning out more work every year are sufficient evidence that there must be some very good reasons for this change in ideas. In studying the early history of the steam turbine, it will be found that the greatest factor tending to retard the advancement of the turbine was not the turbine itself, but the difficulty of finding a suitable and satisfactory machine that it could drive. The troubles experienced with generators in the early days are ancient history, and with the applications of the small turbine for auxiliary purposes, history is again repeating itself. The small turbine has been established for a long time, but many difficulties have been encountered in the satisfactory production of efficient generators, pumps and blowers in order to make the whole unit a commercial success. The makers of this apparatus have appreciated the indisputable advantages of the turbine drive and have laid themselves out to cater to this field, resulting in commercially satisfactory machines to fill the place of practically all engine- and electric-driven auxiliaries in the past.

Considering the three types of prime movers for auxiliary machinery, there are the electric drive, the reciprocating engine and the steam turbine. The motor drive may sometimes be most efficient, but this is questionable when exhaust steam can be used. It is the simplest form of drive, is clean and can be installed in a simple manner. There are no steam pipes, pet-cocks or other encumbrances. Against the electric drive, there have to be faced the disadvantages of probable electrical leakages and the serious accidents resulting therefrom.

While in Europe the electric drive has been the most popular for many years on account of the use of the economizer in those countries in place of feed-water heaters, many of the latest stations are now changing over to steam drive for their auxiliaries. Reliability in auxiliary machinery is of vital importance and it is obvious that, by taking the energy from the primary source of power and from the supply least likely to fail, namely, the boiler, the chances of breakdown are minimized.

Advantages of Turbine over Reciprocating Engine

For steam-driven auxiliaries the choice is between the reciprocating engine and the turbine. The reciprocating engine naturally requires more attention than a motor, cylinder lubrication being almost invariably necessary, resulting in the discharge of oil to the heater or to the condenser, and therefore to the boiler. Again, there being more working parts, the wear of reciprocating engines is greater than in a motor. With regard to the steam turbine, this approaches the simplicity of the motor as nearly as it is possible for a steam unit to do. The number of bearings is the same and the duties on the bearings are approximately the same; therefore the attendance of the two units can be said to be about equal. In favor of the turbine over the reciprocating engine, are the elimination of pet-cocks and the danger of water-hammer and internal lubrication, and, with the introduction of superheated steam to modern plants, the consensus of opinion at the present day seems to be that the turbine is by far the more suited to this work than the reciprocating engine. The simplicity of the turbine, and its limited amount of necessary attendants, is a factor bearing directly on station costs in view of the cheaper grade of labor permissible.

One great drawback to the turbine for years has been the ignorance of the average engineer as to the mechanical construction of these machines, to-

gether with a prejudice against their apparently high speeds. The turbine maker is probably a great deal to blame for this condition of affairs, it having been the policy to keep the construction of the machines dark. A broader view, however, exists at the present time, and consequently engineers are becoming more experienced and now feel themselves competent to take care of these machines without having to send to the manufacturer for the smallest repair or adjustment that may be necessary.

Efficiency of Small Turbine

With regard to the efficiency of the small turbine, both with regard to a comparison of different types and to a comparison with motors or reciprocating engines, the writer would like to enlarge on the real meaning of efficiency. The question of water rate does not cover the situation. In a 5000-kilowatt turbine, the consumption of each pound of steam per kilowatt means probably $2400 per year. In a small turbine, a difference of one pound per horsepower in a 100-horsepower machine means for the same period of operation, $48 per year.

Practically all small turbines on the market at the present time can be improved in water-rate efficiency. This can be done by increasing the speed in revolutions per minute or by increasing the peripheral velocity, using larger wheels, or by an increased number of stages. All these points mean additional complication, additional weight and higher first cost.

For the sake of argument, a single-stage turbine with a 2-foot wheel, if increased 3 inches in diameter will bring down the water rate from 38 to 36 pounds; in other words, a saving of 5 per cent. would mean an increase in weight of the whole turbine of about 17 per cent. The increase in floor space would be 10 per cent., and the increase in the cost or selling price would be approximately 15 per cent. The point then for the designer to consider is where to draw the line between absolute water rate and commercial efficiency.

It is obvious that a comparatively slow-speed machine will give less trouble, not only to itself but to the other end of the apparatus, and a breakdown due to over-sensitiveness on the part of the turbine of high efficiency will soon run away with the money saved by the increased efficiency.

For example, assume a 100-horsepower turbine of a slower speed to consume 2 pounds more per horsepower than another, which means an additional cost of about $96 per year. This $96 per year means 4 cents per hour, and the difference between the cost of unskilled labor necessary for the one machine and the skilled labor necessary for the attention of the other generally amounts to much more than this. Assuming the case of an exciter running a large engine, one hour's shutdown per year at the rate of 3 cents per kilowatt-hour will more than pay for this additional coal bill.

Supposing again the turbine is to run the condensing apparatus, the difference in steam consumption of a 5000-kilowatt machine running over from condensing to noncondensing will take a running period of only six hours to pay for the $96 additional coal consumed. This question of reliability is, to the writer's mind, not sufficiently emphasized, and should be considered an absolutely direct part of the efficiency factor, and the average engineer is now sufficiently well versed in the construction of steam turbines to be able to determine for himself what he can expect in overall efficiency when given the water rates and the construction of the various machines.

Not a "Steam Hog"

With reference to the actual water rates obtained, the idea existing among many engineers that the turbine is a "steam hog" is entirely erroneous, as will be shown. Of course, examples can be found every day where conditions are such that if economy is a factor to be considered, poor judgment was shown in the first instance in ever installing a turbine. This state of affairs is not by any means confined to the small turbine; many examples of it may be seen in the larger marine installations.

In practice, the engineer does not care about turbine water rates. He is interested in his overall water rates per air, electrical or water horsepower, as the case may be, and instead of always criticizing the turbine end, it is the other end that for many years has needed reforming.

Water-rate Efficiency

The work of the builder of the other apparatus has resulted in a unit which can hold its own against all competition, not only in reliability but in actual water-rate efficiency. It has been a practice for years to run gas blowers at turbine speeds, but as there were no turbines in the earlier days, the belt drive was adopted. Later installations are using the direct turbine drive with the same blower speed as previously, which gives a better overall efficiency. A fair figure at the present time for a modern gas-plant operating with 125 pounds steam noncondensing, with a turbine of 100 horsepower, is about 70 to 80 pounds per air horsepower with a blower pressure of 22 inches.

In some tests quoted by Mr. Morehouse in a paper read before the Southwestern Gas & Electric Co. on an engine-driven fan of 6000 cubic feet capacity, with 20 inches pressure, the water rate per air horsepower was 141 pounds. Some recent tests on a turbine blower of slightly larger capacity, also operating under normal gas-works conditions, show an actual water rate of 76.2 pounds. In some of the later installations, higher blower pressure is being employed. Not only does the turbine efficiency in this case increase, but the fan efficiency also. In a recent test carried out on a 40-inch blower for the Brooklyn Union Gas Company, 58.5 pounds per air horsepower was obtained, with a steam pressure at the throttle of 145 pounds noncondensing.

Further tests on this equipment show a turbine water rate, when operating with 117 pounds steam and 5 pounds back pressure, of 36 pounds per brake horsepower or a Rankine cycle efficiency of 49.8 per cent. This figure is remarkably good, but it only shows what can be done in other installations if the apparatus to which it is connected can be brought up to the same standard of efficiency as can the turbine at turbine speeds.

The question of generator efficiency is no longer an unknown quantity, and guarantees made on brake horsepower can readily be verified from the electrical readings. It is unfortunate that the same cannot be said with regard to pumps and blowers, and it is often found that where a guarantee is made by the turbine builder and it apparently falls down on an actual test with a blower or pump, the pump is not operating under conditions called for in the contract and it is therefore not running at anywhere near the efficiency specified.

Comparative Performances of Turbine- and Engine-driven Pumps

With regard to the comparative performances of turbine-driven and engine-driven pumps for boiler-feed purposes, some interesting comparisons are obtainable from the tests made on board the scout cruisers "Birmingham," "Chester" and "Salem." Together with these figures are given the water rates that are obtainable from the modern turbine boiler-feed pump, showing a marked increase in efficiency in favor of the turbine-driven sets. See table on page 10.

The assumed pump efficiency equals 85 per cent. and the assumed engine efficiency equals 90 per cent. on reciprocating sets.

Napier's Formula

On the general subject of the steam consumption of small steam turbines, it is strange that Napier's simple formula* for the flow of steam through nozzles cannot be used to greater commercial advantage than it is at the present time.

$$*W = \frac{PA}{70}$$

where
W = Weight of steam per second
P = Absolute higher pressure
A = Area of passage in square inches

This well known formula has been proved so many times to be approximately correct that it is a pity that it is not more used to compute the steam consumption. The majority of small turbines now operate with a terminal pressure at the jet below 0.58 of the initial pressure, so that this formula can be readily applied to any machine and the steam consumption determined by placing a gage in the steam ring.

The maker could be called upon to give the number and the size of the jets, and in this way an instantaneous reading could be taken at any time showing the amount of steam passing at any one time. If this were done, less claims would be made that a turbine is passing a greater amount of steam than the makers claim for it. Of course, when it comes to a question of pump efficiency, this is a harder matter to determine, and it is possible that at a given water horsepower the turbine does require more steam than called for. This can only be tested out by means of a dynamometer or brake to find out where the trouble lies.

By a slight modification to the constant 70 in Napier's formula for various jets, figures can be obtained as accurate as is possible by actual measurement. In a series of tests carried out within the last few days on a certain machine, in seven readings with a ring pressure varying from 40 to 150 pounds, the minimum discrepancy between the calculated and the actual results was 1.3 per cent. and the mean over all the readings, 0.443 per cent.

The actual figures obtainable on test and those calculated are as follows:

Napier's Formula	Actual Tests	Per Cent. Variation
2028	2043.6	0.8
1264	1248.0	1.3
1935	1934.0	0.0
2625	2638.0	0.4
1905	1906.0	0.0
3047	3066.0	0.6
2272	2272.0	0.0
		3.1
	Average,	0.443

Simplicity of Design

The construction and the general design of small turbines have been so thoroughly dealt with in other papers that it is not considered necessary to go into this phase of the subject. The writer would, however, like to bring forward the fact that in small turbines, as in the larger units, the design and mechanical construction are all-important factors. What is considered good practice in the design of large turbines is, however, in many cases a mistake in small machines.

As to the details of the machine, the design should be as simple and the governor and other mechanism attached thereto as fool-proof as possible, even at the expense of efficiency if necessary. The wheels, etc., should be readily accessible, as facilities for handling such machines in the places where they are so often installed are very inadequate for this purpose, and the time allowed for the dismantling of an auxiliary is often only a few hours at the middle of the night.

That machines are designed to fulfill these requirements, and that complications in the design are unnecessary are proved by the constructions now employed. For example, it is thought by some engineers that the single governor mounted directly on the turbine shaft cannot be made sufficiently sensitive for close regulation. Figures taken from some recent government tests on Terry turbines show that this is by no means the case.

On a series of six consecutive 5-kilowatt machines for the navy, the official figures were as follows: Maximum jump of the worst machine, with full load thrown off, 3.28 per cent.; average maximum jump over the six machines, 2.61 per cent., with a mean settled variation of 1.19 per cent.

On two 85-kilowatt sets, also for the navy, the mean figure of the two machines were, maximum, 2.77; settled, 2.09.

WATER RATES OF SMALL TURBINES

	Steam Pressure, Pounds	Back Pressure, Pounds	G.P.M.	Head in Feet	W.H.P. Water Rate	Turbine, Pounds	Per Cent. Improvement
"Birmingham"	183	6	329	488	83.0	61.8	25.5
"Salem"	203	6	193	690	91.8	61.2	33.6
"Chester"	187	6.7	219	610	101.0	64.0	34.6
					275.8	187.0	93.7
Average					91.9	62.4	31.2

Discussion

Mr. Orrok, of the New York Edison Co., said that in his own practice he did not often consider the water rate of a small steam turbine. He knew that under any condition of use it was better than that of the reciprocating engine which it displaced. Maintenance and upkeep were the things to look to. The Edison Co. had yet to spend its first cent for repairs on a small steam turbine, of which it has 40 in service and the oldest ones have been in operation for five years. As to the labor of running them, a man looks at them once or twice a watch, puts his hand on the bearings to see that they are not warm, and that is all the attention they get. No oiling to do, no pet-cocks to try, no wiping, no taking apart to see what is the matter with them, or picking out rust or scale, or filling oil cups, or a hundred and one other things that happen with reciprocating engines.

Mr. Cooley stated that his company had eight or ten small turbines running on pumps, a small condenser and other machines. They had had one or two bumps which were not in any way the fault of the turbine. They had a runaway on one machine, caused by a lack of a strainer on the steam pipe. A small screw came in and caught under the governor valve, and the turbine went fast enough to throw out the blades of the fan connected with it until they hooked on to the cutoff blade of the fan. The blades came out of the fan and the fan came out of its bearings. If a thing like that happened to a reciprocating engine it would be necessary to pick up the pieces in a basket. All that was necessary in this case was to replace a sprung shaft. There had been a little trouble due to the fact that the machines ran fast enough to set up a vibration on the floor, but this was remedied by placing them at proper points.

Comparison between the largest passenger locomotives built for the Pennsylvania Railroad and the oldest locomotive in America shows the progress made since the first railroad train was put into service at Bordentown, N. J., on the Camden & Amboy Railroad in 1831—eighty years ago. The oldest locomotive, "John Bull," is still intact at the National Museum in Washington. The locomotive which the Pennsylvania Railroad has adopted for heavy passenger service is of the Pacific type, and it is the most powerful passenger locomotive in use on the Pennsylvania Railroad. The locomotive and tender when loaded with coal and water weigh about 430,000 pounds. The "John Bull," loaded for operation, weighs 24,625 pounds, about one-seventeenth as much as the new engine, which has six driving wheels 80 inches in diameter. The driving wheels of the old engine are only 54 inches in diameter. The boiler of the new locomotive contains 359 tubes, each 20.9 feet long, making a total of nearly a mile and a half of 2¼-inch tubes through which the flames and heat from the firebox pass on their way to the stack. The heating surface of the tubes is 4420.6 square feet and, in addition, the firebox has a heating surface of 199.3 square feet. This space is heated to a high temperature to convert the water in the boiler to steam at a pressure of 205 pounds per square inch. The tubes in the "John Bull" are 7½ feet long, and the tube-heating surface is only 213 square feet.

Large Turbine at Providence

By John R. Hess

Description of a new 15,000-kw. turbo-generator installed at the Manchester St. station of the Rhode Island Co.

The new 15,000-kw. turbo-generator built by the General Electric Co. for the Rhode Island Co., of Providence, R. I., was put in regular service at the Manchester Street power station on Sunday, Nov. 26. It supersedes the 1500-kw. horizontal reciprocating engine-driven unit and occupies less than one-half the ground area required for the latter. The weight of the new machine and auxiliaries is approximately 500 tons and its cost, including the switchboard, three rotary converters, condensers, etc., was $340,000. It is of the vertical, four-stage Curtis type designed to operate at 750 revolutions with 150 lb. steam pressure and 75 deg. superheat.

The generator is of the three-phase, 25-cycle, 11,000-volt type. The rating is based upon a rise of 75 deg. C. with a room temperature not exceeding 25 deg. The speed variation is not to exceed 2 per cent. The steam-consumption guarantee calls for an economy of 17 lb. at 7500 kw. and 16.2 lb. at 15,000 kw. when operating with a vacuum of 28 in. However, as it is the expectation of the company to operate this turbine with 150 deg. superheat and a pressure of 160 lb. steam pressure, it is presumed that at 10,000 kw. (the average output) the steam consumption will approximate 15.2 lb. of steam per kilowatt-hour.

Owing to the capacity of this machine and the characteristic of the load curve, it is expected that it can take care of the entire output of the plant without assistance from the other units during 300 days of the year.

The condenser is of the twin-suspended LeBlanc type, having one exhaust head connected to the turbine and is capable of handling 8,000,000 lb. of cooling water per hour. One peculiarity of this condenser is that it is supported upon a steel column, the top of which is on a line with the base of the turbine. There is a clear space under the condenser of approximately 12 in., which allows the expansion to take place downward should the vacuum be lost and the temperatures rise accordingly; in this way there is no tendency to throw the turbine shaft out of position.

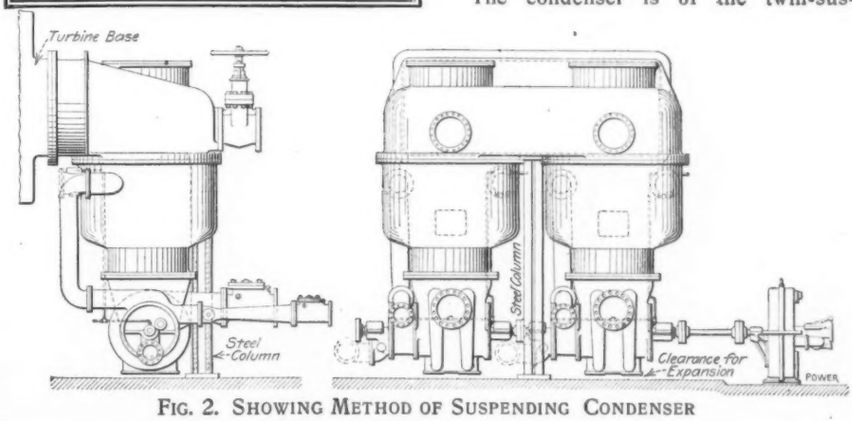


FIG. 2. SHOWING METHOD OF SUSPENDING CONDENSER

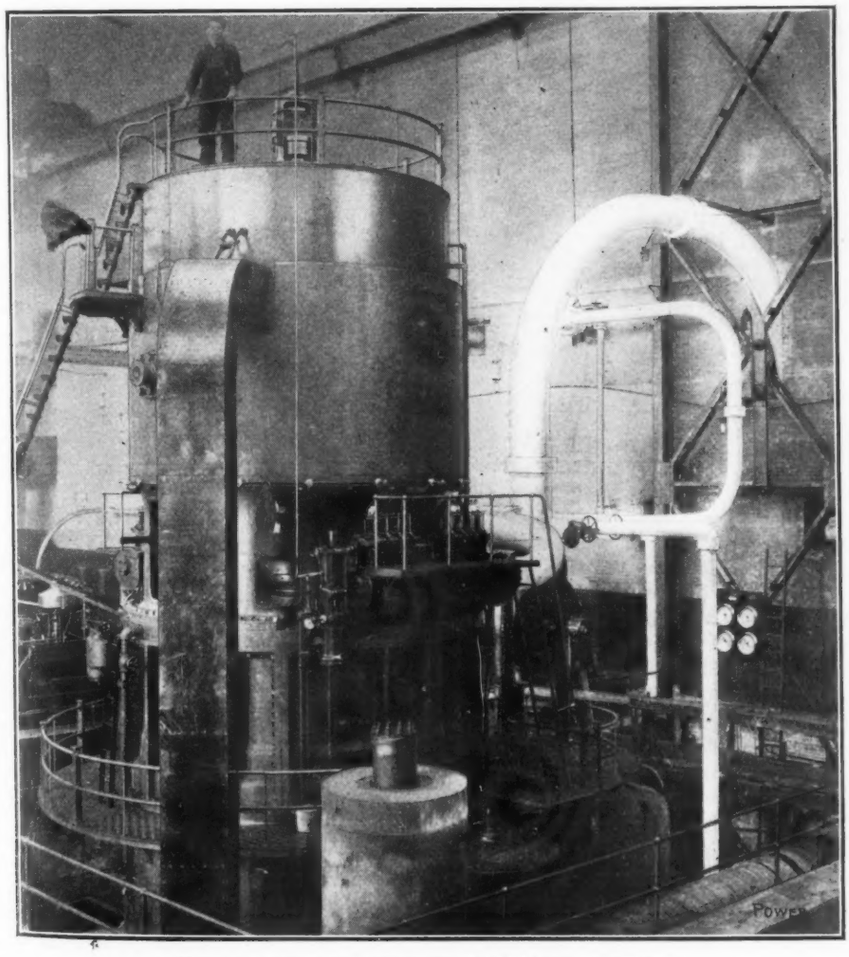


FIG. 1. GENERAL VIEW OF 15,000-KW. TURBINE

Before selecting this type of unit, various studies were made of the low-pressure turbine, and it was found that as the load upon the station increases, the steam-consumption curve of the high-pressure turbine, as adopted, would be practically the same as if low-pressure turbines had been employed. Therefore, the overall economy of the station will be less with the high-pressure turbine than if low-pressure turbines had been specified. The arrangement also gives greater simplicity in the installation and operation over any low-pressure turbine installation.

The company now has 12 units with a capacity of 53,000 horsepower.

The English bankers, Lazard Frères, have invested $3,000,000 in Vancouver Island coal properties. The investment will be largely devoted to exploration work and for installing haulage power, made possible by hydro-electric plants.

Coal Delivery, Candler B'ld'g, Atlanta

By R. C. Turner

By purchasing its own coal-storage yard and substituting an automobile truck for the mule teams formerly used in carting, the company has effected a considerable saving.

Considerable space has been devoted by the technical press to describing coal and ash handling in the boiler rooms of power plants, but very little has been said of cutting the cost of delivery to the isolated plants located in the business districts of cities, a mile or more from the railroad; here the problem of cartage is very important. At the plant of the Candler Building, in Atlanta, Ga., this problem has been solved very satisfactorily. It is one of the largest isolated stations in the South, using on an average 20 tons of coal per day, although during the winter months as much as 30 tons are often used in a single day. In order to get a satisfactory price on the coal the management found it necessary to take four cars per week throughout the year.

Owing to the slow placing of the coal cars in the yards by the railroad company, which would leave them first in one yard a mile from the plant and next in a different yard possibly two miles or more from the building, great delay was caused in getting the coal for the building.

After spending considerable money for extra teams and demurrage, the owners of the building decided to build their own yard and do their own carting. At this yard, which was 1½ miles from the building, a sidetrack 350 ft. in length comes in from the railroad. When brought in, the cars are immediately switched onto the trestle and the coal is dumped into the bunkers 15 ft. below, the average time required to empty a car being 10 minutes. As soon as the cars are emptied the railroad company is notified, and they are hauled away. Demurrage is now a thing of the past.

The coal is carted to the plant in a five-ton motor truck, the illustration showing it discharging coal to the boiler room, 30 ft. below the street level. Four loads of five tons each are delivered to the building per day and two loads of cinders and refuse are hauled away and delivered to the purchasers of this waste material. On Saturdays, 40 tons, or eight loads, are delivered, thus avoiding a Sunday delivery.

Before adopting the motor truck two double teams and four men were required for this service. A comparison of the two outfits is as follows:

Old Service—Investment		
Two wagons	$400.00	
Four mules at $225	900.00	
Stables	600.00	
Four sets of harness	100.00	$2,000.00
Operating Expenses—One day		
Four men, labor	$6.50	
Feed	1.60	
Depreciation, wagons and stock	0.70	8.80
New Service—Investment		
One motor truck	$3,800.00	
Shed at coalyard for housing truck	200.00	4,000.00
Operating Expenses per Day—New Service		
Two men, labor	$2.75	
Nine gallons of gasoline, at 11 cents	0.99	
Oil and grease	0.20	
Depreciation	1.00	$4.94

The investment at the coalyards is $1200. It is estimated by the managers of the building that the saving in demurrage charges alone will pay 8 per cent. on the total investment. As coal is the most expensive item in the operation of any power plant, any improvement that will lessen the cost is welcomed by the engineer.

When the subject of buying a motor truck was considered various types were investigated before placing the order for the machine. For a while the electric truck was seriously considered, but owing to the excessive weight of batteries and the amount of dust and dirt that would be encountered in the service it was decided that an electric truck would not be as efficient as the gasoline. The truck selected is a four-cylinder, water-cooled machine rated at 70 hp. After being in service for several months the only repairs that have been made or needed were new linings for the brake bands.

TRUCK DISCHARGING COAL

Seneca River Boiler Tube Blowout

In the Nov. 28 issue of POWER there was reported a fatal accident due to the blowout of a tube in a 400-hp. Babcock & Wilcox boiler used on a canal dredge in Seneca County. Since then there have been two coroner's hearings for the purpose of fixing the responsibility of the accident and there is likelihood of several more. From an engineering standpoint, however, the direct cause of the accident has been fairly well established, details only being necessary to make it complete. It was shown that the failure was due either to defective material, to material weakened by pitting or corrosion, or to material weakened by overheating, there being nothing to show the existence of an excessive pressure.

The following pertinent facts have been established at the coroner's hearings:

The insurance-company inspector who passed upon the boilers last September made a thorough examination of the port boiler only, the one on the starboard side being in operation at the time of his inspection. (The starboard boiler was the one that failed.) In his opinion, the boilers and equipment were among the best in use on the barge-canal work. This inspector is expected to testify at a later hearing.

The safety valve had blown properly several times the day before the accident, and was set at about 200 pounds.

Leaky tubes had been reported in the port boiler shortly before the accident, and it was planned to replace 12 old tubes in both boilers with new ones in a few days. No evidence was brought out to show that the starboard boiler was under suspicion, nor was it declared why it was decided to replace any of the tubes. The tubes of the starboard boiler were, so far as was known, the ones furnished originally by the makers when the boiler was installed three years ago.

After the accident, the broken tube and eight others were replaced with new ones. According to the master mechanic of the dredge, the eight tubes removed showed bulges indicating overheating.

Upon first thought it seems likely that the disaster was due to low water, the steam that did the damage coming from the port boiler. In this case mostly steam would have escaped into the boiler room. It can be shown by computation that the heat stored in the normal contents of such a boiler under the existing conditions is sufficient to evaporate about one-eighth of its weight. This type of boiler of a size warranting a 400-hp. rating would contain normally about 330 cu.ft. of water. A blowout in one of the lowest row of tubes (which was where the trouble occurred) would therefore allow the conversion of about 40 cu.ft. of water into steam at atmospheric pressure, the greater part of the balance of the boiler's contents emitting as water at 212 deg. Obviously, then, if normal water level had existed just before the accident, a considerable amount of water would have appeared in the boiler room after it, and the lack of this would show conclusively that the failure was due to low water at the time.

The condition of the boiler room regarding wetness was investigated at the last coroner's hearing, and the testimony showed that its floor was "covered with puddles." Although this does not absolutely dispense with the low-water theory, it is strongly against it. Furthermore, if the boiler had been operating at its rated capacity, it would have taken between 1 and 1½ hours to uncover the upper ends of the lowest row of tubes, assuming the feed water to have been entirely shut off. It seems hardly likely that such a condition should have obtained for so long a time and happen coincidently with a false water level. It was testified that the water column, shortly before, showed 4 in. of water.

It seems reasonable, therefore, to look elsewhere for the cause of the overheating. If it happened just before rupturing, it may have been due to impurities such as mud sufficient to impede the circulation. But an elaborate filtration system was used to keep the river mud out of the feed water, and, although this does not make an accumulation of it in the boiler impossible, it does render improbable that hypothesis. This leads to the conclusion that the overheating was done some time prior to the accident, the metal being bulged and weakened only at that time, and giving away later under the caprice of circumstance. On the other hand, it is odd that a bulge which must have been in plain view on the tube that failed, not to speak of the eight other defective tubes, should have escaped observation for any length of time. The fact that there were leaky tubes in either boiler seems to be aside from the point, except in that such leaks may have drawn attention away from the object of real suspicion.

A few general remarks regarding boiler-explosion inquiries may not be amiss. It seems improper that such an investigation should be conducted by lawyers who have no knowledge of the conditions bearing upon such an accident and who cloud the issue by magnifying trivialities. In this particular case, local sympathy for the victims and prejudice against the barge-canal construction contribute to obscure the facts. That there were leaky tubes, to the lay mind, shows conclusively that the boilers were in seriously bad condition, and if an accident accompanies that condition, by the same false reasoning, this incontrovertibly links the cause to its effect. It seems that a board of expert and impartial engineers should be employed to pass upon the causes of boiler explosions. Investigations would then be carried out along logical lines and only factors pertinent to the case would be considered. The legal responsibility could then be fixed by their findings.

Taking Chances with Old Boilers

By Charles F. Adams

Every year in the heating season there appear in the newspapers and engineering periodicals sundry accounts of failures of old boilers used only during this season, for heating, ice harvesting, etc.

An example of a "chance" which, if an accident occurs, will be up to somebody to explain, can be seen in the conditions under which two boilers, used to furnish heat for passenger cars in a local railroad storage yard, are operated. One of these boilers is said to be more than forty years old, and was described in an article entitled "Old Boilers in Massachusetts," appearing in the Dec. 6, 1910, issue of Power in which it was said to be the oldest boiler in high-pressure service in the state, a claim which has not as yet been questioned.

View of One of the Old Boilers

It would be supposed that the age of this boiler would furnish a sufficient incentive for maintaining a close observation over it; apparently such is not the case. The last inspection was made July 30, 1910, and, although the plant was idle during the past summer, and the records must show that the time of inspection had passed, no objection was made to the boilers being put into service this season. That the boilers have not received the benefit of even a change of water since the last season is manifest, as both blowoff cocks are plugged with pipe plugs, which are corroded and rusted, showing that they have not been opened for a long period. Both boilers

present a much patched and dilapidated appearance, as may be seen from the accompanying illustration.

The following data are taken from the inspection certificate posted on the wall:

No. 1. Age, unknown; builder, unknown; length, 16 ft.; tensile strength, 45,000 lb. per square inch; thickness of shell plates, ⅜ in.; type of joint, single-riveted lap; strength of joint, 49 per cent.; type of boiler, locomotive; diameter of shell, 48 in.; thickness of head, ½ in.; pressure allowed, 52 pounds.

No. 2 is described as: Age, 26 years; builder, unknown; length, 16 ft.; tensile strength, 45,000 lb. per square inch; type of joint, double-riveted lap; strength of joint, 62 per cent.; thickness of head, $\frac{7}{16}$ in.; pressure allowed, 52 pounds.

Caught in the Economizer Flue

By E. R. Emerson

"Talking about frights, well, I don't think anyone will care to have a fright and shock similar to the one I had some 25 years ago," began Bill, the engineer. So we all drew a little closer; we knew Bill could tell a good tale when he got started.

"I'm not likely to forget it in a hurry, either. You see my hair," said Bill, lifting his cap. We all noticed how snow white it was, but until now had never thought anything about it as Bill looked over 50 years of age and white hair is not uncommon at that time of life. "My hair was as white as it is now three days after the affair I am going to tell you about, and I was then only 23 years of age.

"Well, to go on with my story, our chief engineer had a habit of putting locks and chains on everything that he thought might be a source of danger; if a boiler was shut down for cleaning he would have the main stop valve and the blowoff fastened with a padlock and chain, until all the work was done, and then he would unlock them, keeping the keys to himself.

"There were six boilers in our plant, connected to an economizer, with a direct flue, so as to divert the gases straight to the stack instead of through the economizer flue when it was desired to clean out the latter flue.

"Two days before we were given orders to clean out this flue, the chief had taken the usual precaution to lock both inlet and outlet doors with a padlock and chain on each, leaving everything secure and ready for the entrance of the cleaners. As soon as the flue was cool enough, I was told to clean out one of the center nests of tubes. I found it to be hotter work than I had anticipated as the feed water from the exhaust-feed heater was still flowing through the economizer tubes, and every time I had my hands on them to steady myself I was forcibly reminded to take them off again.

"All went well until I started to clean down the tubes next to the outlet door. This door, of course, was shut tight and was supposed to be securely padlocked on the outside. When the economizer was in commission this door led direct into the fan chamber and then to the stack. I had just started to clean down the first row of tubes on the fan side from the door, when suddenly there was a tremendous roar and I felt myself lifted bodily from the floor of the chamber. Next I was jammed tight against the hot tubes, but for the presence of which the fierce draft would have carried me through the door; hot ashes burned into my skin and flesh and my clothes were soon in flames. Instinctively I clutched the tubes, but how they scorched me! At last I felt my strength giving way, my eyes were filled with fiery dust and every breath I took was like molten metal filling my throat and lungs. I had a vague idea of a thousand demons prodding me with pitchforks; then I must have swooned, for I imagined myself being drawn through the fans and sailing all serenely up the smokestack, wondering what I should do when I got to the top.

"When I came to they had cut off my burning clothes, and were dabbing oil all over me. Oh, how my eyes and throat smarted!

"However, after a few weeks in the hospital I was about again and, with the exception of my hair, which was then just as white as you see it now, I had no disfigurement whatever.

"It was while convalescent that I learned how the affair happened. It seems that it was due to the smartness of an 18-year-old youth that I owe my life. He was working at the other end of the economizer close to the door leading outside and, hearing my shout, rushed outside, jumped up onto the top of the economizer, colliding with the chief in his hurry, and rushed to the outlet-door handle. He swung it around with such force that he nearly broke the door.

Suddenly There Was a Tremendous Roar and I Was Jammed against the Hot Tubes.

"By this time the chief had reached his side and, looking round, he was astonished to discover a crowbar lying there and the chain broken into two pieces. Telling the boy to stick to the handle, he soon had me brought out.

"When all was over, he went through to the engine room and was just about to hold an inquiry in an effort to find the fool who had done the mischief, when his eye fell on the log sheet. There in bold characters he read in the 'remarks' column:

"'Noticed economizer handle out of place at 10:39 a.m.; straightened it with a bar; all well.'

"I don't know exactly what the chief's remarks were to the new switchman, but I rather think they were hot ones."

Electrical Department

Conducted to be of service to the men in charge of electrical equipment in the power house

Catechism of Electricity

INCANDESCENT LAMPS—THE VAPOR TUBE LAMP

1175. *Are there any other forms of incandescent lamp?*

Yes; there is one more general class known as vapor-tube lamps. Fig. 393 shows the Cooper Hewitt direct-current mercury vapor lamp, which is one of this class.

1176. *Describe the construction of the mercury vapor lamp.*

It comprises a clear glass tube *N* about an inch in diameter and from 20 to 50 in. long, in which is a small quantity of mercury. This tube, like the filament-lamp bulb, has the air pumped out and is sealed. The mercury is held in the large bulb *A* at the left end of the tube and serves as the negative electrode. The positive electrode is a small iron cup *C* at the right end of the tube. Platinum wires sealed in the glass carry the current to the electrodes. The current passing from one electrode to the other vaporizes some of the mercury, and it is this vapor which emits the light. The inner surface of the reflector *S* is finished in smooth, white porcelain.

The part *M*, shown separately in Fig. 394, contains two inductions coils *N* and *L*, and an adjuster resistance *B* by means of which the current is regulated according to the voltage of the supply. For lamps connected in series, a shunt resistance *T* and a cutout *O* are also included. The binding posts *X* and *Y* are for the leads to the tube, and the binding posts *P* and *F* are for connection to the supply wires.

1177. *How is this lamp lighted?*

By closing the switch controlling the circuit and then pulling down the chain *R*, Fig. 393, attached to the left end of the holder. This pours the mercury out of the bulb along the tube. The stream of mercury is thus momentarily made to connect the electrodes and the breaking of this continuous stream lights the lamp.

1178. *Is no provision made for automatically relighting this lamp in case of an interruption of the current supply?*

Provision for automatic relighting is made only in the automatic type of Cooper Hewitt direct-current lamp shown in Fig. 395, the tilting being here accomplished by means of an electromagnet in the part *D*. When the circuit is closed through this lamp the current flows through the electromagnet which tilts the tube for lighting. This automatic tilting is desirable in places where it would be difficult to reach the chain by hand; and it also insures the relighting of the lamp in case there is a momentary interruption of the current supply.

1179. *In the lamp shown in Fig.* 395, *are the two tubes connected in series or parallel?*

In series.

1180. *What is the rated candlepower and what the efficiency of the lamp shown in Fig.* 393?

The candlepower is 300 and the efficiency is 0.64 of a watt per candlepower.

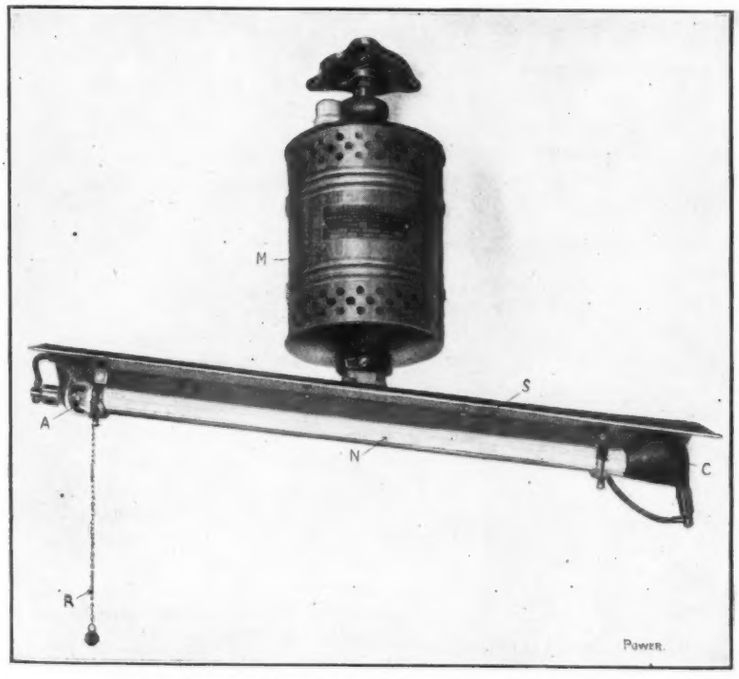


FIG. 393. COOPER HEWITT MERCURY VAPOR LAMP

FIG. 395. DOUBLE-TUBE MERCURY VAPOR LAMP

1181. *Is the mercury vapor lamp made for alternating-current circuits?*

Yes. The mercury vapor lamp for alternating-current circuits differs from the direct-current lamp somewhat. The principal difference is in the auxiliary part, which contains a transformer for supplying the proper voltage to the tube electrodes, two choke coils, a shifter consisting of a small glass vessel fitted with two electrodes and containing a small quantity of mercury for lighting the tube, and the shifter resistance.

1182. *How often must the glass of a mercury vapor lamp be renewed?*

After about 3750 hours of service.

1183. *What kind of light does the lamp give?*

A greenish-colored light which has great penetrating power. It enables printed matter to be read with unusual ease and brings out with great clearness the fine markings on steel rules, and small scratches and defects on other bright metals.

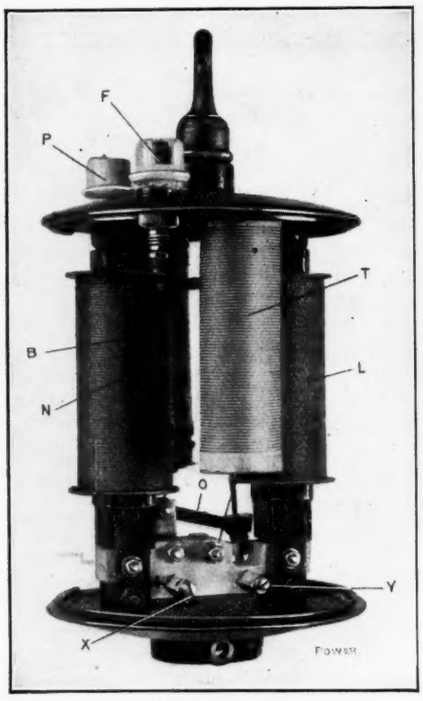


FIG. 394. MECHANISM OF MERCURY VAPOR LAMP

gas contained in a glass tube from which the air has been pumped out.

1185. *What kind of light is given by the Moore lamp?*

A clear, white light of about 200 candlepower, possessing practically the same color values as natural daylight. The Moore light is therefore particularly advantageous in matching colors at night or during dark days.

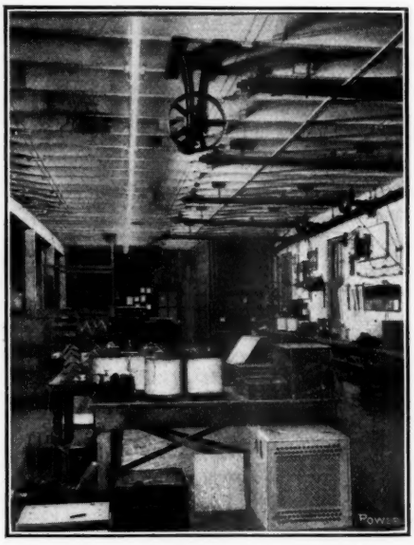


FIG. 397. STRAIGHT-LINE MOORE TUBE

1186. *Does the carbon dioxide gas become exhausted?*

It does, and for this reason there is a compartment behind the glass tube *G*. Fig. 396, containing the gas which is fed automatically by means of an electric valve into the tube as it is needed. The carbon dioxide in the compartment has to be renewed after about 1000 hours of service. On account of a deposit gradusally forming in the tube *G*, the tube also has to be renewed after 4000 or 5000 hours of service.

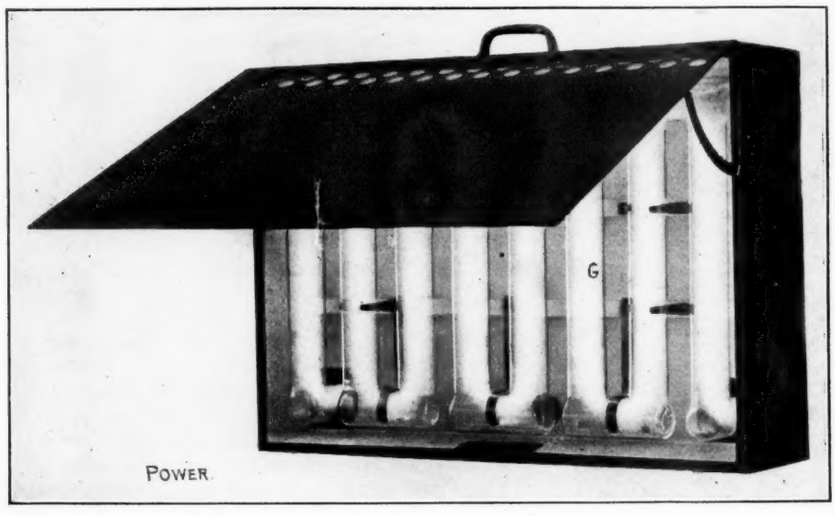


FIG. 396. MOORE VAPOR-TUBE GLOW LAMP

1184. *Is there any other form of vapor-tube lamp?*

Yes. The Moore lamp shown in Fig. 396 is classed as a vapor lamp because light is produced in it by passing an alternating current through carbon dioxide

1187. *How much current does the 200-candlepower Moore lamp require?*

At 110 volts it requires 23 amperes; at 220 volts, 11½ amperes.

1188. *Is this lamp made in any other form than shown in Fig. 396?*

Yes; for the general illumination of large areas the glass tube, instead of being arranged in gridiron fashion, as in Fig. 396, is straight and intended to be hung from the ceiling, as in Fig. 397, or made a part of the cornice. In this form it gives "line" instead of "spot" lighting. If nitrogen gas instead of carbon dioxide gas be used in the tube, a yellow light can be produced instead of a white light.

The Wrong Bearing Heats

BY J. E. LATTA

The necessity of the correct alignment of the bearings on any machine having more than two bearings on the same shaft is too well understood to need discussion now, and the evils of extremely tight belts are also very generally appreciated. However, some recent troubles with bearings, which seemed to be due to the belts having to be run too tight, I have never fully understood. There was a large belted alternating-current dynamo, of the revolving-field type, with a pulley 24 in. in diameter, which was driven by an engine having a belt-wheel 12 ft. in diameter, the distance between the center of the dynamo shaft and that of the engine being only 23 ft. Naturally with such an extreme layout as this, the belt had to be very tight in order to prevent it from slipping badly. The dynamo bearing next to the belt never showed any signs of heating, but the other one always became very hot on long runs.

The heating invariably began at the bottom and spread slowly throughout the bearing. We tried all the usual remedies for the trouble, except that of moving the machine farther away and using a longer belt, such a change as this being impossible on account of the lack of room. Half a dozen different grades of oil having been tried had the usual applications of sulphur, graphite, sapolio, etc., having proved ineffective, we tried raising the shaft of the dynamo slightly by putting paper liners under the bearing, thinking that the resulting lengthening of the lower portion of the airgap and the consequent lessening of the downward component of the magnetic pull on the revolving field might relieve the trouble. But the heating persisted as bad as ever. During long runs in hot weather we were forced to apply ice to the bearing in order to keep the generator going.

The provisions for driving a 50-kw. alternator in this plant were about the same as those just described, and on a

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24-hour run the bearings of this machine behaved very much like those of the larger generator. It is not at all clear to me why it was always the bearing opposite the belt which got hot, nor why the heating always began at the bottom of the bearing.

We never allowed either one of the bearings mentioned to get hot enough to require much scraping. In this connection, it may be appropriately remarked that many engineers are inclined to use the babbitt scraper more than is necessary or desirable. However, I will appreciate any suggestions that other readers may offer as to the reason why the heating occurred in the bearings not subjected to belt pull.

An Electrically Driven Blowing Engine

By S. R. Stone

An interesting example of the adaptation of electric drive to the modern high-duty blowing engine is afforded by an installation at the Mammoth smelter, near Kennett, Calif., of the United States Smelting, Refining & Mining Co. Here the forward end of a standard duplex machine, with cylinders 44 and 44 by 48 in., is driven by ropes from a 75-hp. 2000-volt induction motor. The blower runs at 75 r.p.m. and supplies, at 15 lb. pressure, 13,000 cu.ft. of free air per minute for the blast for copper converters. Regulation of the supply is effected by automatic throttling of the air inlets. This permits the motor to run constantly at maximum speed, which benefits the power factor of the system.

The use of a motor instead of a steam engine was brought about by the fact that the company has no boiler plant but operates its mines, smelter and trams by means of electric power obtained from the hydro-electric development of the Northern California Power Co. Other conditions being equal, a direct-connected blowing engine would perform the same service on not more than 700 b.hp. and with considerably greater efficiency.

LETTERS

Mr. Hawkins' Compressor Motor

Referring to the letter of J. C. Hawkins, in the Oct. 31 issue of Power, regarding the sparking of a 7½-hp. shunt-wound motor, I would say that sparking, from any cause, would heat up the whole motor to an extent depending on the amount of sparking. In all probability the damp condition surrounding the running of this motor has a good deal to do with it. As to the question of whether a compound-wound motor would give better results, while I do not know all the conditions under which this motor is running, before condemning the shunt-wound motor I would suggest to Mr. Hawkins to try the plan of soaking the carbon brushes in machine oil for 24 hours, then wiping clean and allowing them to dry for six or seven days. With a narrow, sharp chisel, cut the mica between the commutator segments down $\frac{1}{32}$ of an inch, as I think his repeated sandpapering of the commutator has left the mica high, which does not allow the brushes to make good contact on the commutator surface. Then with the mica cut down and the commutator clean, put on the oil-soaked brushes. While this may not stop the sparking entirely, I think it will give a great degree of relief.

Herbert Hill.

Middle Falls, N. Y.

[Since the above was received we have been informed by Mr. Hawkins that a compound-wound motor has been put in in the place of the old one and it runs without giving any trouble. The difficulty would seem, therefore, to have been that the current rushes due to the compressor strokes went beyond the sparkless limit of the constant-field (shunt-wound) machine.—Editor.]

In regard to the trouble with our shunt-wound motor driving an ammonia compressor, I wish to comment on the several answers to my inquiry and state how the trouble was stopped.

The sparking occurred at all times, but it was worse when making the compression stroke, although an ammeter in the line showed only about 3 amperes fluctuation, the range being from 26 to 29 amperes. The motor is rated at 7½ hp. at 220 volts and stamped for 30 amperes full-load current. The voltage at the machine was 222.

In reply to my original letter, Mr. Scott said that a compound-wound motor would not give better service on this intermittent load than a shunt-wound motor, and stated cases that had been cured of a similar trouble by building a higher foundation to raise the motor off the floor and putting in a larger motor. Mr. Jackson gave several conditions, any one of which might cause similar trouble, but neither he nor Mr. White (in the same issue) says anything regarding the compound-wound motor. Mr. Jackson is correct in that the motor did run very hot, and in a very short time after cleaning the commutator it became blackened and scored, as I stated in my previous letter.

Perhaps Mr. Jackson's theory in regard to the field strength of the different poles and improper spacing of the brushes is the correct one, but the motor was new and not only our electricians but an expert from the makers did everything they could think of to make the motor run satisfactorily, as the acceptance of the whole plant was being held up on account of the motor.

About the middle of October the shunt-wound motor was taken out and a 7½-hp. compound-wound motor was placed on the same foundation. During the two months that it has been running it has shown no signs of sparking, it runs quietly and cool, and the commutator is smooth and has been cleaned with No. 00 sandpaper only once during this time.

My opinion is, as it was at the time of my first letter, that as the load ranges from practically no load on the suction stroke to full load on the compression stroke, nothing but a compound-wound or an interpolar motor should have been installed in the first place.

This view is based on the results of several years of experience in a plant where there were some 75 motors, many of which were used on punch and shear machines, air compressors, cold-pipe saws and other similar machinery. All of the motors were compound wound and some of them had displaced shunt-wound motors. Furthermore, I have received a letter from the General Electric Co., stating that a compound-wound motor, preferably of the interpolar type, should have been used.

I thank those who replied to my letter of Oct. 31; the information will no doubt be of help at some future time.

J. C. Hawkins.

Hyattsville, Md.

What Causes the Exciter to Rattle?

We have a direct-connected alternator and a belted exciter. At rated speed and up to half load it runs perfectly. Any more load causes it to rattle or vibrate. The vibrations do not coincide with the number of revolutions per minute.

The exciter has been examined and each part tested by four engineers. There seems to be nothing loose; the armature is in balance, but the bearings are slightly worn now as the machine has been running about six months.

It has always given the same trouble. At first the pulley was out of balance, but that has been corrected with no benefit. I have tried running it without the pulley, as a motor, but it still rattles. Can anyone tell why?

W. M. McGinnitie.

Haddock, Wash.

Dyeing Incandescent Lamp Bulbs

Will some one of the readers of Power tell me what process to use for coloring incandescent-lamp bulbs red?

Harry L. Seifts.

Philmont, N. Y.

Gas Power Department

Worth-while gas-engine and producer information treated in a way that can be of practical use

The Smith Recording Gas Calorimeter

The accompanying illustrations represent the two elements of an equipment devised by H. F. Smith, the well known producer engineer, for continuously measuring and recording the heat value of gases. The equipment comprises a sampling pump, Fig. 1, and a recording calorimeter, Fig. 2. The sampling pump consists of a rotary air pump and a reciprocating gas pump having a common shaft driven by an electric motor through single-reduction spur gears. The two pumps deliver air and gas to the calorimeter at a constant volume ratio, the inequalities of pressure in the gas-pump

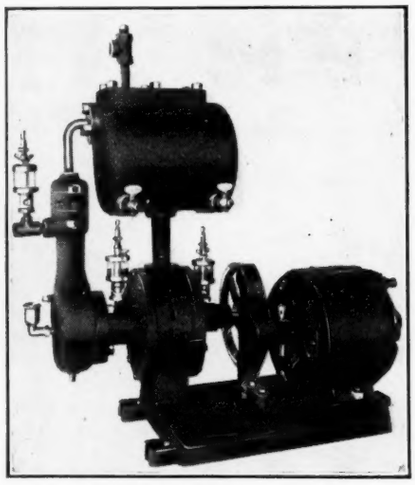


FIG. 1. SAMPLING PUMP

cylinder being smoothed out by the little holder shown above the pump. The air pump is used merely to displace the air required for the calorimeter, and since the air is delivered under practically no pressure, there is very little if any slip.

The gas pump is of the single-valve type, the discharge valve being a poppet valve covering the entire area of the cylinder. The inlet is a port entirely surrounding the cylinder, and it is uncovered by the piston at the downward end of the stroke. The piston is six diameters long, and is ground to a very close fit in the cylinder. Since the piston over-travels at both ends, the volume of gas displaced at each stroke is the volume contained between the upper edge of the inlet port and the discharge valve, at the time the piston covers the inlet port on its up stroke. Consequently, there is no variation in the amount of gas delivered, due to variations in the length of stroke. The pumps are calibrated so as to deliver one volume of gas and 29 volumes of air; in practice this calibration has been found to be quite permanent. The gas and the air from the sampling pump are conveyed through separate pipes to the calorimeter proper.

The calorimeter housing consists of a labyrinth of thin steel tubes, the outer one forming the frame of the instrument. The air supplied to the calorimeter first enters the space between the outer tube and the next one within, and passes down through this space, through a communicating passage at the bottom into the space between the second and third tubes, passing upward through the second and third, and at the top into the space between the third and fourth, and so on to the center. The central tube constitutes a combustion space, the gas being led directly into this space through a burner tube in the bottom of the instrument. The gas burns directly in and with the air supplied by the sampling pump, and the heat generated by combustion is employed in raising the temperature of this air; the rise in the temperature of the air is taken as the direct measure of the heat value of the gas.

The rise in temperature is measured by an expansion couple. The low-temperature or zero member of this couple is the outside tube of the set, previously mentioned, which constitutes the frame of the instrument. This tube is exposed on its outer surface to the surrounding atmosphere and on its inner surface to atmospheric air that has been delivered by the pump. The high-temperature member of the couple consists of a steel tape attached at its lower end to a bearing pin which in turn is supported by the outside steel tube or low-temperature member of the couple. The other end of this tape is connected to a system of multiplying levers which record the difference in length, and consequently the difference in temperature between these two members. By making the high-temperature member thin, the instrument is made very sensitive to small variations in temperature. In practice a double steel tape 0.015 of an inch thick is found to give excellent satisfaction. Owing to the fact that this tape is always at a high temperature no corrosion is experienced, even with gases very high in sulphur.

With the air-to-gas ratio of 29, a temperature difference of 1 deg. C. is about equivalent to 1 B.t.u. per cubic foot of gas under standard conditions. The temperature difference in producer gas of 150 B.t.u. would therefore be approximately 150 deg. C. The products of combustion being discharged at temperature above the point of saturation, the readings are always in terms of net or low heat value.

It is not immediately apparent why this instrument will give readings that are automatically corrected to the accepted standard of temperature and barometer, but a brief consideration will suffice to show why this is. It should be observed, to begin with, that changes in either temperature or barometer change the density of the gas; both of these

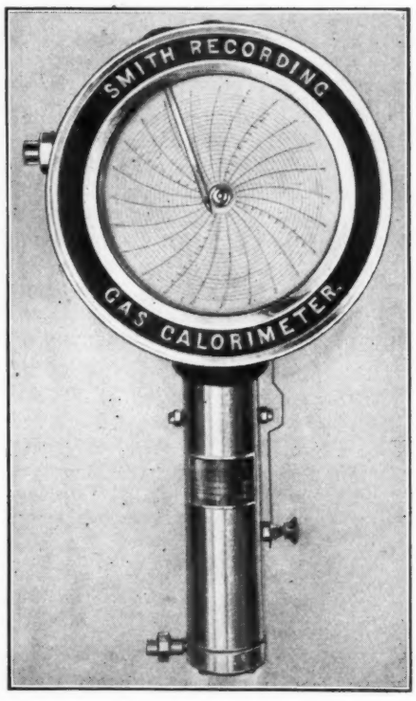


FIG. 2. RECORDING CALORIMETER

factors may therefore be considered at the same time. Assuming the instrument to be operating under standard conditions, on producer gas of about 150 B.t.u., the sampling pump will deliver in a certain time 1 cu.ft. of standard gas and 29 cu.ft. of standard air. The combustion of the gas will cause a temperature rise of approximately 150 deg. C. In other words, 1 cu.ft. of gas will heat 30 cu.ft. of mixture 150 deg. C.

Now assume that, owing to changes in barometer or temperature or both, the specific volume of the gas is double its original bulk. The gas, however, is delivered to the sampling pump under the same conditions of pressure and temperature as the air; that is, at atmospheric temperature and at atmospheric pressure. If, therefore, the gas is delivered at one-half normal density, the air will also reach the sampling pump at one-half its normal density, and in the same period of time as before, the sampling pump will deliver what is equivalent to ½ cu.ft. of standard gas and 14½ cu.ft. of standard air. It is very evident, however, that ½ cu.ft. of gas will heat 15 cu.ft. of mixture through exactly the same temperature range as 1 cu.ft. of gas will heat 30 cu.ft. of mixture. Therefore, under these new conditions, the temperature difference produced in the calorimeter will be exactly the same as though the instrument were operating under standard conditions. The only requisite is that the gas and the air should be delivered to the sampling pump at the same temperature and pressure, and this condition being met, the readings of the instrument will always be in terms of standard gas at sea level, theoretically.

Of course, in practice this is not strictly true. The radiation losses from the instrument would be proportionally greater with the smaller number of actual heat units per minute liberated in the instrument, but over any ordinary range of conditions the error is not of sufficient magnitude to be of any importance. For example, a change in conditions that is equivalent to a change in altitude from sea level to 6000 ft. elevation will cause about 1½ per cent. deviation from actual sea-level readings. It would no doubt be possible to construct an instrument on this principle that would compensate for all variation in temperature and pressure, but this refinement has not been attempted on this instrument because Mr. Smith did not consider such extreme accuracy necessary in producer practice.

It has been suggested that the condition of the air entering the calorimeter with respect to its content of water vapor would have an appreciable influence on the readings of the instrument, owing to the fact that water vapor has a specific heat of about 0.48, whereas the specific heat of air is only about 0.24. It should be observed, however, that the specific heat is calculated on the basis of unit weight, and that the specific gravity of steam is only about one-half that of air; therefore, the heat-absorbing capacity of water vapor per unit volume is almost exactly equal to that of air. Consequently, except in instances where the greatest possible refinement is required, the percentage of water vapor is of no consequence. With respect to radiation losses, it is explained that the labyrinth construction of the calorimeter reduces these to a very small amount.

The advantages of the instrument may be briefly summed up as follows: It is a commercial power-plant appliance that will run continuously with practically no attention. Inspection of records made under different conditions soon enables the producer fireman to determine the best available fuels, the best operating conditions and, above all things, gives an immediate solution of that perplexing question of responsibility in gas-power plants as to whether trouble lies in the gas producer or the gas engine. Mr. Smith informs us that it has been found possible by the use of this instrument to control the quality of gas made from bituminous coal so closely that a variation of not more than 10 B.t.u. per cubic foot will occur.

The instrument is manufactured by the Lexington Instrument Works, Lexington, Ohio.

The Cost of Oil Power

At the New Haven meeting of the American Society of Mechanical Engineers, a paper on the above subject was read by Messrs. F. P. Pfleghar and E. H. Lockwood. An abstract of this paper was published in POWER for Dec. 5.

In the discussion which followed the reading of the paper, Mr. Krah, superintendent of the plant containing the oil engine which was the subject of the tests reported in the paper, said that his experience with the engine had been that it gave more trouble than a steam engine, because of the high temperatures involved, and the cost of repairs is high.

The exhaust valve ought to be taken apart [?] every week and cleaned, which takes a man four or five hours. The engine has never delivered its full rated horsepower, he claimed, because the fuel oil is not thoroughly vaporized, and cleaning out the carbon deposit due to this fact takes a long time.

During the summer, he said, the oil engine was very economical but in winter he thought it cheaper to run the steam engine because of the need for heat, which is supplied by exhaust steam. Moreover, the oil engine was not considered sufficiently reliable to justify taking out the steam plant.

The paper by Messrs. Pfleghar and Lockwood, abstracted in the Dec. 5 number of POWER, affords a very striking comparison of oil-engine and steam-engine costs in actual operation. Those who heard the discussion of this paper, however, will recall that the statement was made by the superintendent of the plant that the oil engine is, unfortunately, still unreliable; owing to serious interruptions to production, the steam auxiliary plant is still maintained. In view of the necessity of this form of insurance, it does not seem unjust to charge the fixed expense of the steam plant against the oil-engine account.

It is therefore pertinent to make further comparison of power costs and I therefore respectfully request that you publish this letter and the following table in which the cost of central-station power is based on existing rates in New Haven:

	Central Station	Oil Engine	Steam Engine
Operating costs per hp per year.....	$53.15	$32.30	$53.00
Fixed charge per hp. per year.....	1.35	19.45	8.90
*Total cost per hp. per year.....	$54.50	$51.75	$61.90

A slight increase in power used would reduce the operating cost per horsepower-year to $50 for electrical energy. Adding the fixed charge, it is apparent that the electrical service is just as cheap as this oil engine has proved to be. There is good reason to expect that the use of say four groups, each driven by a 25-hp. motor, will effect some saving in power, due to elimination of a single long shaft and heavy belts carrying all the engine power. The cost, however, is based on an actual motor output of 90 hp. for a 3000-hour year, supplied from 25-hp. motors. All losses due to interruptions would, of course, disappear with installation of motors, and the speed of automatic machines should prove more uniform and satisfactory.

C. R. BEARDSLEY.

Bridgeport, Conn.

[It seems very evident that the oil engine under discussion either has had to contend with some very unusual adverse conditions, not brought out in the discussion, or else is one of those "black sheep" which occasionally get out of a factory and cast discredit on the other ninety and nine. Certainly, the average performance of oil engines is not as discouraging as Mr. Krah's lament indicates this one to be.

Mr. Beardsley fails to consider the use of steam for heating, in the case of the steam plant, and his fixed charge of $1.35 against the electrical equipment looks rather modest.—EDITOR.]

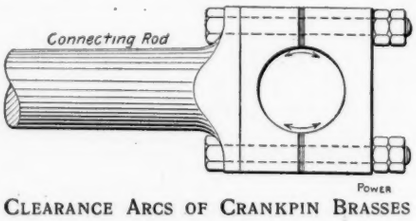
Some Notes on Gas Engine Bearings

BY J. E. LATTA

There is perhaps no more prolific nor frequent source of hot bearings than that of carelessness or a lack of skill on the part of the erecting engineer, or, what amounts to the same thing, on the part of the man drawing the plans to be followed by the erecting engineer. If, for example, the foundation of an engine is so designed that there is appreciable vibration in the running of the machine, serious and frequent trouble with the

bearings is almost inevitable. In one case an 80-hp. engine vibrated so badly, even when running at only half load, as to produce an annoying rattling of the windows in residences 200 yards away, while the shaking in some railway offices half that far away was so violent that the clerks constantly complained of its interfering with their writing.

The engine was of the twin-cylinder type, with six crankshaft bearings. To keep them from becoming very hot, very often, proved to be altogether out of the question. While this is decidedly the worst case of vibration that has ever come to the writer's attention, it is but one of a number of personal observations of the necessity of smooth, steady running on the part of engines and other machinery. If correctly designed and properly erected, the average engine, no matter what the type, will run practically free from appreciable vibration. It cannot usually be expected to do this, however, if the foundation does not rest



CLEARANCE ARCS OF CRANKPIN BRASSES

on a solid support, nor if the foundation is too small and therefore too light. It is a truth which needs emphasis that the man who is erecting an engine should not forget that a generous use of concrete in the foundation may mean a great future saving in oil and babbitt and service interruptions.

On certain types of engine the crankpin box is liable to be a source of considerable annoyance during the first few months the engine is run. Sometimes there will be sufficient pounding to reduce the thickness of the babbitt lining rather rapidly, making it necessary to take up the bearing more or less every few days. Moreover, it may happen that the babbitt will be hammered out at the edges so much that the connecting-rod will be left with such a small amount of side play at the crank end as to make it difficult for the engineer to determine, in adjusting the bearing, just when it has been taken up enough. In such an event it becomes necessary, of course, to scrape the edges slightly; but care must be taken not to cut away too much of the babbitt, for if the crank end of the connecting-rod is given too much freedom of motion along the pin, heating is quite liable to result.

It is good practice in starting up a new engine to scrape the crankpin bearing lightly along the arcs indicated by the double-headed arrows in the accompanying sketch. Since this portion of the bearing is never called upon to do much work, there is no reason why it should fit the pin as snugly as the rest of the bearing surface.

It took me several years to learn that the babbitt in the crankpin bearing may be broken by the pounding which is a too common accompaniment of the running of many engines. This sometimes happens, and, what is worse, a piece of the broken babbitt may become lodged in an oil groove and cause the bearing to be burned out. For some reason or other, it is usually the babbitt in the outer or forward half of the box which breaks. In gas or oil engines, this breaking may be caused by the shocks due to preignition of the explosive mixture. I have known engineers to spend many weary hours in futile efforts to adjust a crankpin box so as to stop it from pounding, when a few gallons of a mixture of one-third of commercial muriatic acid to two-thirds of water, by volume, run through the cooling jackets of the engine cylinder to clean out the mud, lime or other formations therein would have silenced the pounding by stopping premature ignition.

CORRESPONDENCE

Points in the Care of Oil Engines

Below are replies to the points raised by S. G. Rose in the Nov. 28 number of POWER concerning my article in the Oct. 24 number:

1. Although the ignition tube may have been heated up enough to enable the engine to be started, this may have been—and generally is—accomplished by pumping the lamp pressure up to a point which may be more than twice the pressure obtaining when running. The result, especially with light loads on a "hit-and-miss" engine, may be that cooling of ignition tube will occur after the engine has been started up. The cooling may be due to faulty burning of the lamp at the working pressure, to the ignition tube being too long or of too great a diameter, or to its orifice being partially choked up with carbon. Mr. Rose is right in his supposition that the engine will not start at all if the ignition tube is not hot enough in the beginning.

2. First of all, it is not every make of engine, by any means, which is provided with a timing valve. Then, it often happens that, with the ignition tube at its normal heat for normal running, an overload will come on, causing the tube to get considerably too hot, with resulting preignitions. This is certainly not to be classed as one of the commonest of oil-engine stunts, but it does occasionally occur and Mr. Rose may possibly be able to trace a "mysterious" trouble to it some day. Mr. Rose's experience as to preignitions with electric ignition is not uncommon, but, as mentioned in my original article, the troubles peculiar to electric-ignition devices are sufficiently numerous to justify an article to themselves.

3. I am aware that the majority of oil-engine handbooks and instruction manuals tell one to keep all valves closed when the engine has stopped. By all means do this when the exhaust line may have any pressure above atmospheric introduced into it by any means, as by the connection of the exhaust pipe of another engine. In my oil-engine experience, however, I have found that if the exhaust valve is left open when the engine is shut down, the pitting and corrosion of its face and seating surface will be greatly minimized. Why this should be so I have not decided quite to my satisfaction, unless it is due to the fact that any moisture which condenses in the cylinder may drain right away instead of being held for some time while it percolates through the annular nick between the exhaust valve and the seat.

In engines fitted with electrical-ignition apparatus the chief argument against leaving the exhaust valve open when the engine is standing is that moisture due to the condensation in the exhaust connections may settle on the plug points. This is the cause of "damp plugs" which often give difficulty in starting up. This trouble is nonexistent in hot-tube ignition.

JOHN S. LEESE.

Manchester, Eng.

Two Cycle Gas Blowing Engines

We read with great interest Mr. A. G. Christie's article on "Developments in Prime Movers," in POWER of Oct. 24 last, and we take the liberty of stating that his view that at present two-cycle engines are almost exclusively used in the German iron works for driving gas blowers, does not quite accord with the actual state of affairs.

Up till now this company alone has installed in such works approaching 90 gas blowers, aggregating aproximately 150,000 hp. and of such engines eight, aggregating 30,000 hp., are being used for driving gas blowers in steel works, while only one or two gas blowers of the two-cycle system are used for converters. The number of four-cycle engines just stated will be increased by the many four-cycle gas blowers supplied by the firms Thyssen, Erhardt & Sehmer, Haniel & Lueg, Friedrich-Wilhelms-Hütte, Mülhausen and others.

It will be evident from the foregoing that the number of the four-cycle gas blowers in use in Germany far exceeds that of the two-cycle gas blowers, although for some time a preference existed for the latter type.

MASCHINENFABRIK AUGSBURG-NÜRNBERG A. G.,
per KUTZBACH and P. MEYER.

Heating and Ventilation

Considered as power-plant problems. Layout and operation of systems and apparatus

Rebuilding Radiators

By L. M. Johnson

In a large Pittsburg office building there has been considerable trouble experienced with the steam-heating radiators. Of the 160 radiators in the building over one-half of them have been rebuilt in the past two years, while the building has been constructed and occupied only ten years.

Attention was at first drawn to the radiators by an occasional leak between two columns. This was at first remedied temporarily by slightly spreading the two columns, wrapping some tape saturated with pipe cement around the nipple and then pressing the columns together again. This was found to be a short-lived repair as the radiators soon began to leak again. As other radiators began to show signs of leaking it was necessary to give the subject more serious attention and find a permanent repair. It was not considered advisable to throw the radiators away and put in new ones, so the method of repair outlined in the following was adopted.

Fig. 1. Prying the Columns Apart

Fig. 2. Inserting a Nipple

Fig. 3. Pressing Columns Together

The construction of many radiators consists of a series of cast-iron columns connected together at the bottom with smooth-face, tapered nipples, commonly called slip nipples. One of these nipples is entered into the reamed hole of a column and another column is placed parallel with it and the end of the nipple started in the opening and then pressure applied until the shoulders of the two columns are pressed together, so that the nipple has an exceedingly tight fit in both columns.

After securing the necessary tools and nipples the order of repair was to take the radiator out and separate the columns at the place which showed the leak, clean out the holes, put in a new nipple, press the columns together again and put the radiator back in service. This method did not prove satisfactory, as the strain on the unbraced columns while placing the repair nipple tended to loosen other nipples that were already becoming weak from corrosion and cause them to start leaking. After this experience it was deemed advisable to take the radiators apart and renew all of the nipples.

Before it was time to furnish heat for the present winter, all the radiators that had given any evidence of leaking were taken to the repair room to be rebuilt. The radiator was placed on a platform of convenient hight, the stay rods were taken out and then it was an easy matter to separate the columns by prying them apart with a long bar, as shown in Fig. 1. The nipples in some cases were so badly corroded that the columns could be separated with the hands. The old nipple, usually remaining in one of the columns, was easily removed by caving in the weakest side and then driving it out from the opposite side with a drift. The holes in the columns were then cleaned out with emery cloth until they were smooth and bright. A new nipple was dipped in a thin mixture of white lead and entered into the column, as in Fig. 2. Another column was then placed parallel to those already assembled and started square on the nipple. When three or four columns had been placed together the screw press and chain were put on and with the assistance of a heavy piece of babbitt metal as a bumper the columns were pressed together, as shown in Fig. 3. These operations were repeated until the radiator was completed. After the radiator has been rebuilt in this way it is apparently as good as new.

In Fig. 4 is shown a pile of nipples that were taken out. It may be noticed that some of the nipples have been corroded all the way through on one side, leaving an opening which was always found on the bottom. A stack of new nipples is also shown in Fig. 4.

Corroded Nipples

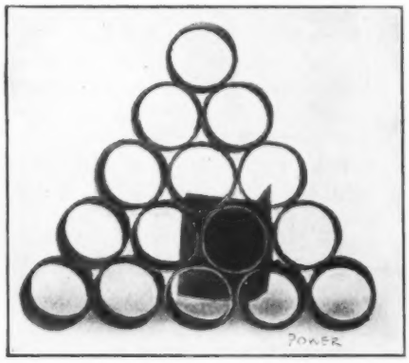


Fig. 4. New Nipples

All the steam-pipe connections were tapped for 2-inch pipe, but the contractor who installed the radiators, evidently to reduce the cost of piping, had reduced the size to the radiators. In the twenty-

three-column radiator the opening was bushed from 2 to 1½ inches; the opening in the thirteen-column radiator was bushed from 2 to 1¼ inches, while the connections in some seven-column radiators were reduced from 2 to 1 inch. A few larger radiators on the first floor were piped with the full-size 2-inch pipe. These gave no trouble, as the 2-inch pipe permitted the radiator to drain below the connecting nipples, while all those that were bushed would not drain below the nipples, thus leaving some water lying on the lower side of the nipple. The radiators with 1-inch connections were the first to give trouble and so on down. It is thus apparent that economy in the piping of the radiators greatly shortened their life.

FIG. 1. A BLOWER ON EITHER SIDE OF CRANE WAY

Heating a Large Shop

A clear conception of the fan system of heating and ventilating an industrial building may be obtained by a glance at the accompanying illustrations. They are views of the new machine building of the Union Drawn Steel Company, Beaver Falls, Penn. The building is of modern construction throughout, being of brick and steel with Fenestra steel sash occupying a large part of the wall. The roof is of concrete about 2½ inches thick and covered with a tar and gravel roofing. The monitor is continuous steel sash.

In this case, on account of the crane way, two separate sets of heating apparatus were installed. Each apparatus consists of a 100-inch double-discharge conoidal fan, direct connected to a 7x7-inch single-cylinder vertical Buffalo engine. The air is drawn through six sections of return-bend heater coils, and delivered to the galvanized-steel ducts which distribute it to all portions of the building. The steam is delivered to the engines at 75 pounds pressure and the exhaust is used to heat the coils. The entire system has a capacity of raising 50,000 cubic feet of air per minute from a temperature of 0 to 110 degrees.

At the same time that this installation was made, a somewhat similar heating and exhausting system was placed in the pickling room of the same company.

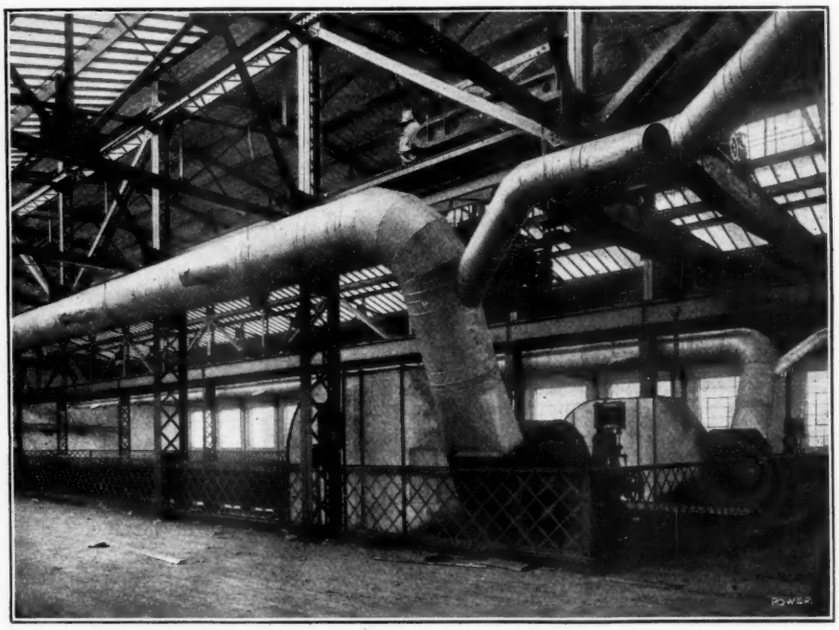


FIG. 2. THE GALVANIZED-STEEL AIR DUCTS

Albert M. Allen & Co., of Cleveland, were consulting engineers for the Union Drawn Steel Company and under their specifications the heating and ventilating systems were installed by the Buffalo Forge Company.

Air Circulation

BY HENRY D. JACKSON

There are many heating installations in which no arrangement has been made to insure a proper circulation of the air, so that the heating is decidedly ineffective. To heat a large space effectively, a thorough circulation of air is necessary; otherwise the hot air will rise to the top of the room, cold air will settle to the bottom, and the gradation of temperature from fairly cold at the bottom to very hot at the top will be the result. This condition has been found in many armories, dance halls, drill halls, etc., where, owing to the requirement that the floor space be not obstructed, the heating coils have been placed high up on the walls and across the building, approximately at the hight of the eaves.

In one instance coming to the writer's notice, all of the heating coils were suspended directly under the trusses supporting the roof, and the steam coils had a capacity representing about 1 square foot of heating surface to 50 cubic feet of building contents. With a pressure of 10 pounds at the coil valve, the temperature on the floor was about 40 degrees during zero weather, while the temperature at the peak of the roof was in the neighborhood of 125 to 130 degrees. To overcome this difficulty, six holes were cut in the floor of the building, one-quarter of the steam pipe was put under the floor, one-half was cut out of service entirely, and one-quarter was left as it was. Heavy grates were placed over the holes and at three of them heavy tin pipes were fastened, extending to within a foot of the ground below the floor. The steam pipes under the floor were placed about one foot below the

floor proper. After these changes were made, steam at a pressure of two pounds was supplied, and within half an hour after it was turned on the coldest place in the room was at 67 degrees. Since these changes were made, more trouble has been experienced in keeping the room cool than in keeping it warm.

Of course, the heated air under the floor rose through the three registers provided for it, and in rising left a space for the cold air on the floor to circulate. This air on being heated will rise and the cold air on the floor will drop, thus giving a thorough circulation of air all through the building.

In most hot-air heating, the location of the registers is decidedly faulty. For proper and active circulation of heat, the hot-air entrances should be approximately 7 feet from the floor and on the walls opposite to the window, so that the hot air on entering the room will rise, flow over toward the windows and, being cooled by this radiation from the windows, will drop to the floor. If the outlets for this air are placed at or about the floor level, the air will circulate along the floor to these outlets and up the exhaust stack.

If the circulation is rapid enough, the difference in temperature between the bottom and the top of the room will not be noticeable, and not only will the temperature be more uniform, but the fresh air brought in through the furnace will enable the occupants to live more comfortably at a much lower temperature. The air supplied should be properly moistened before it enters the supply pipe, as moisture has a marked effect upon the temperature at which one can live comfortably.

LETTERS

A Water Heater Problem

The scheme described by N. S. Rice in the Dec. 5 number to heat water for the office would doubtless work as described, although I would imagine cooling part of the feed water after it leaves the heater would not be good practice.

If the drip or condensation from the heater were run through the small tank there could be no objection; a drip or return from a few radiators, during the cold weather, would also do the trick, the ¾-in. brass pipe being used in either case.

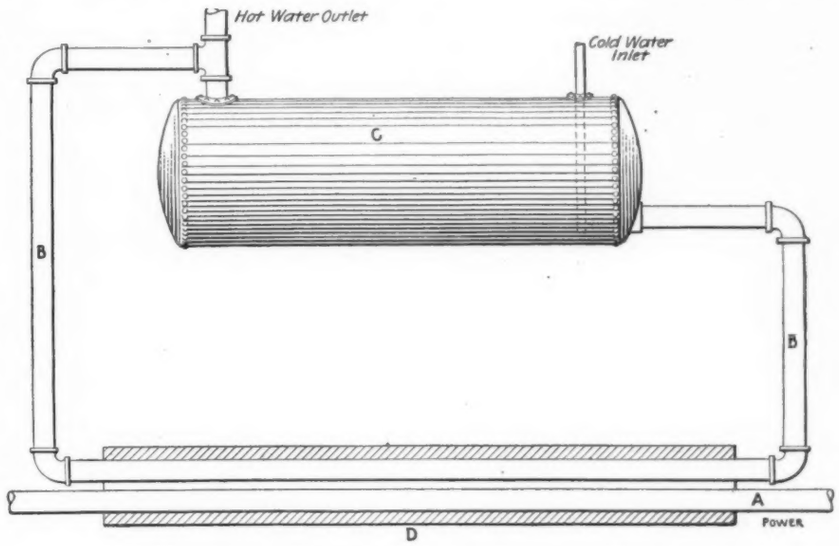
When such a small quantity of water is required, a scheme such as is shown in the accompanying illustration could be used. Here *A* is a live-steam pipe, *B* a circulating pipe, *C* the reservoir for hot water and *D* indicates pipe covering.

As may be observed, the circulating pipe passes through a piece of pipe covering and is in contact with a steam pipe.

If there is a hotwell into which drips and condensation return and from which the water is pumped to the heater, another plan could be used. Instead of placing a pipe in contact with a hot pipe, as suggested above, it could be submerged in the hotwell. Any of these schemes would supply the apparently small quantity of water necessary in the case in question, and none of the boiler-feed water would be reduced in temperature.

JAMES THORN.

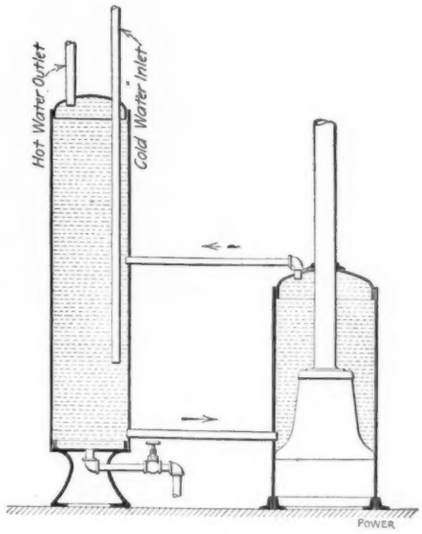
Toronto, Can.



SCHEME FOR HEATING SMALL QUANTITY OF WATER

Piping a Water Heater

In looking through some of the back issues of POWER, I happened to read Mr. Noble's letter on connecting up water heaters. In my opinion, his method is at variance with the common principles of water circulation. Does Mr. Noble expect the heated water to fall down to the bottom of the tank or is it to be used as heated? The manufacturers put the hole in the middle of the tank so that there will be a thorough circulation of water and always a one-half drum of hot water in reserve. I have connected up hundreds as shown in the attached sketch, and they have always given satisfaction.



PROPER CONNECTIONS FOR GOOD CIRCULATION

In his letter appearing in the Nov. 21 issue, my opinion is that the saving will be chiefly on paper. The designer decided that a 5-in. exhaust was required; then somebody comes along and partially blocks it up. This will cause a higher back pressure. The engine naturally takes more steam to drive a given load, and it will take very little more steam to "eat up" one ton of coal a week on that size of engine. The exhaust line appears to have enough elbows and length without blocking it up. From the elbow to the tee, shown in the sketch, the size of the pipe should have been increased to 6 inches.

The outlet of the coil should enter the drum about the middle of its length, so that the lime will be precipitated and not scale up the pipes. The circulation being constant, the drum would not then be subject to the violent shaking and hammering that takes place when it is connected up as indicated in the sketch.

H. JONES.

Montreal, Can.

Petroleum has been found in Alaska, and while there has been practically no production, it is not impossible, according to the United States Geological Survey, that commercial pools may be found. Oil seepages occur on the west shore of Cook Inlet, on the east side of the Alaska Peninsula, and on Controller Bay, all close to tidewater, and hence capable of cheap development.

United States Overfeed Stoker

The American Stoker Co., 11 Broadway, New York City, has placed upon the market an overfeed stoker, which is shown in the accompanying illustrations.

It consists of an ordinary fuel hopper in the bottom of which are reciprocating, adjustable pushers, which shove the coal into the furnace upon the top grates. The back plate of the hopper, which is exposed to the furnace fire, is water cooled to prevent the destruction of the plate by the furnace fire, and also to keep the plate so cool that the coal will not fuse in the hopper and prevent the proper feeding of the fuel.

A short pusher is employed at each side of the stoker to provide means for feeding fuel to the sides of the grates irrespective of the amount of coal fed to other parts. This provides a means of preventing air holes forming along the side walls of the furnace.

The grate surface (except the ash dump) is composed of a series of horizontal shelves arranged as steps, as shown in Fig. 1. They extend across

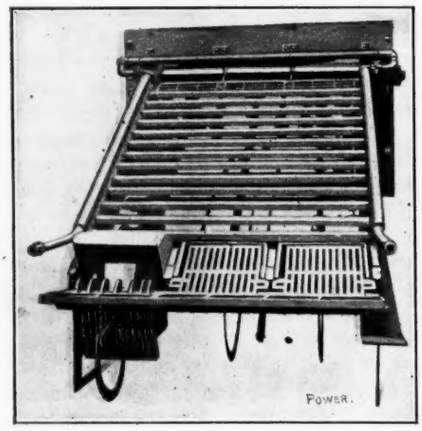


FIG. 1. SHOWING TERRACED GRATES, DUMPING GRATES AND CUTOFF PLATE

the furnace and form an incline of about 36 deg., thus providing abundant air space between the grates. The grates are formed of two series, alike in design, but arranged alternately fixed and moving, as shown in Fig. 2. The fixed grates are bolted to the side risers adjacent to the furnace walls and additional stationary risers extending through the center portion of the stoker. The moving grates are interleaved between the fixed grates and are supported and securely bolted to moving risers, which are supported at the lower end by rollers and at the upper end by arms attached to eccentrics mounted on the stoker shaft.

By an arrangement of a knuckle-joint swing link and setscrews the motion of the grates may be modified to suit the particular requirements of different kinds and grades of fuel. For a coal subject to coking, the grates may be adjusted to travel in the path of an ellipse, as shown by the dotted lines in Fig. 2; or the grates may be changed so that the forward motion may be a straight line, while

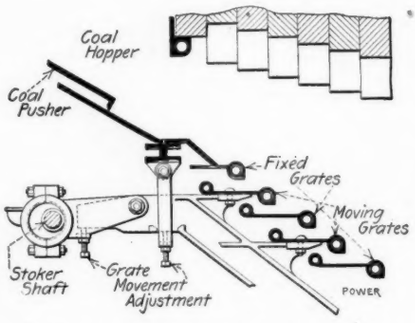


FIG. 2. MOVING AND FIXED GRATES

in retreat the grates may lift more or less than in the arc of an ellipse, carrying the grates clear of loose coal which may be on the rear of the grate below. The motion of the grates is such that the coal is compelled to travel at a uniform thickness from the top or front of

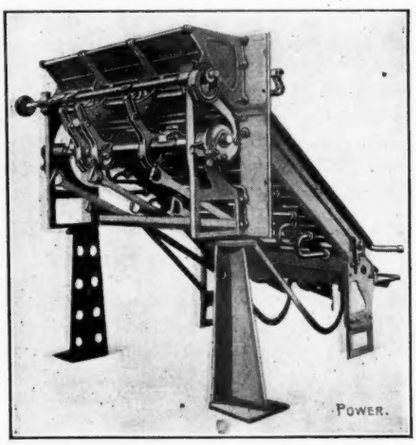


FIG. 3. FRONT ELEVATION OF STOKER, SHOWING ACTUATING MECHANISM

the furnace to the rear. Each grate assumes the rôle of a positive pusher in its relation to the next. This applies to the coal and burning fuel and the ash and clinker also, so that the latter are precipitated upon the ash dump at the rear and bottom. As the grates overlap, even fine fuel will not sift through the grates.

The ash and clinkers are extracted and separated from the good fuel by the attendant by the simple operation of the parts, and, during the process of dumping or after, cold air is not admitted to the furnace as the space occupied by the dumping grate is covered with burning fuel. Fig. 1 shows the special dumping arrangement.

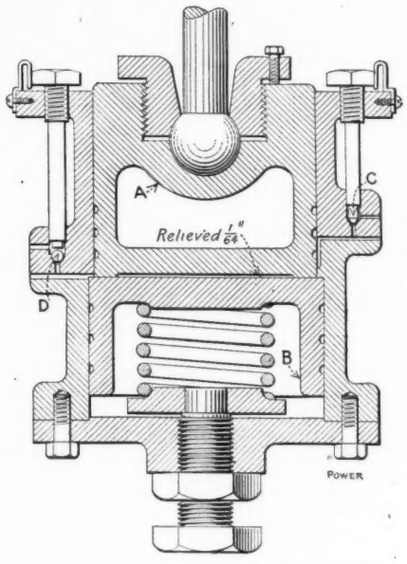
Partly embedded in the bridge-wall is a "water back" cylinder which is constructed of standard steel boiler plate and connected direct with the water circulation of the boiler. It is provided with standard-size boiler manhole and blowoff pipe for cleaning. Its purpose is to prevent the adhesion of clinkers to the bridge-wall.

Each grate bar is protected from burning by a continual stream of water passing through that portion which is in direct contact with the burning fuel. The pipes used for this purpose are extra-heavy, cold-drawn seamless tubing and are tested under a pressure of 1000 lb. per square inch, and are cast in the grate. The connections from one grate to another are made by U-shaped pipes with unions having ground ball bronze seats. The connection is shown in Fig. 2.

Treating the moving grates as one unit and the stationary grates as another, water connection is made direct with the boiler to the bottom grate of each series, thence ascending from grate to grate until the top is reached, where another connection leads to the steam space of the boiler. There is no moving joint in connection with the entire installation.

Miller Quick Acting Vacuum Pot

The accompanying illustration shows a cross-section of a Miller vacuum dashpot. When the plunger *A* is released the air which was taken in through the air valve *C* is discharged through the ad-



MILLER QUICK-ACTING VACUUM POT

justable check valve *D*. When the plunger *A* drops, the piston *B* will take the thrust noiselessly and without a jolt, due to a cushion of air and the give of the spring, which is strong enough to quickly reseat the piston *B*. This action forces out the remaining air and causes the plunger to seat quickly. The air valve *C* can be adjusted to diminish or increase the

amount of air taken into the cylinder to suit the spring, which is also adjustable.

This device is the invention of F. B. Miller, 147 Fourth street, Milwaukee, Wis.

Wheeler Barometric Ejector Condenser

This condenser has been designed to operate in connection with reciprocating engines where a high vacuum is not demanded for economical steam consumption and where a short exhaust-pipe connection is not essential.

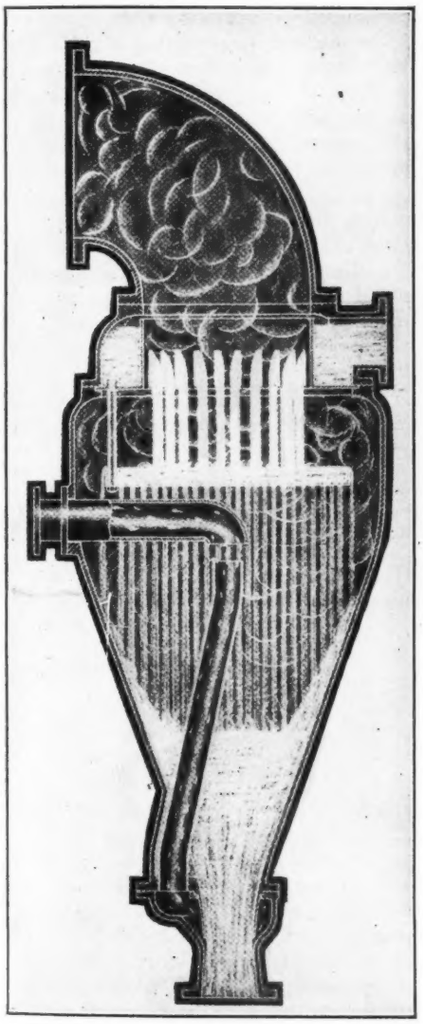


FIG. 1. INTERIOR VIEW OF BAROMETRIC EJECTOR CONDENSER

The condenser consists of a pear-shaped body, Figs. 1 and 2, with a large exhaust-inlet opening at the top and an opening at the side for cooling the water. At the bottom, connection is made to the barometric column which discharges the water to the atmosphere without the aid of a tail pump.

The sectional view, Fig. 1, shows that the condensing water is distributed in an annular reservoir which has vertical slots in its inner wall through which the water falls in numerous small streams in the direct path of the exhaust steam.

The falling water from this annular distributer is collected upon the tray placed immediately beneath and is distributed so as to fall through the small openings in this tray in a fine rain to the bottom of the condenser, where it again comes in contact with the exhaust steam.

Air may be drawn from the condenser either by the water ejector or by both the ejector and a dry-air pump which may be connected to the opening shown at the left of Fig. 1. As the water falls down through the condenser shell air is

FIG. 2. EXTERIOR VIEW OF EJECTOR CONDENSER

entrapped and is carried out through the converging nozzles of the shell, and at the same time the water acquires a higher velocity so that at the neck of the condenser an ejector action is set up. The air supplied through the lower pipe, shown in section, is thus carried out through the ejector to the atmosphere. The barometric column attached to the bottom of the condenser is approximately 34 feet in hight, which insures that the water and air will be delivered to the sump at the foot of the column against the pressure of the atmosphere.

For intermittent service this condenser will maintain a good working vacuum without the use of an air pump. Where the conditions are such that a better vacuum is desired, a dry-air pump used in connection with the condenser will maintain a vacuum up to 29 inches of mercury.

This condenser is manufactured by the Wheeler Condenser and Engineering Company, Carteret, N. J.

The "Hypress" Blower

Simplicity in small pieces of apparatus is highly desirable for the reason that the small machine is often the victim of

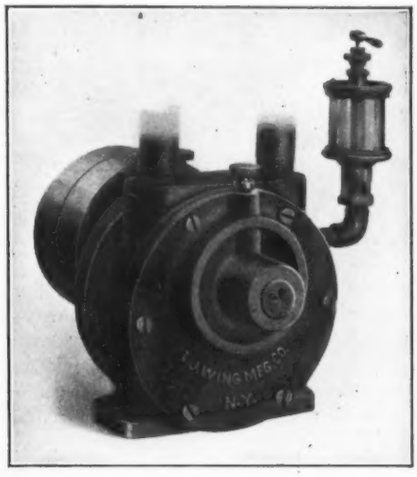


FIG. 1. THE "HYPRESS" ROTARY PRESSURE BLOWER

gross neglect. Once it is put into operation it must go on and on with hardly a glance from the man who has charge of it. Often it is installed where there is no one who has much, if any, under-

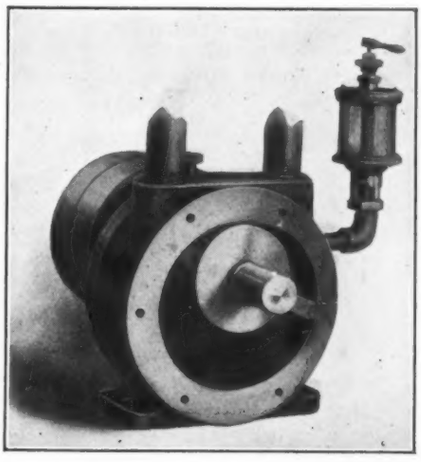


FIG. 2. BLOWER WITH COVER REMOVED

standing of machinery, and hence it receives no intelligent attention whatever.

The rotary-pressure blower which is illustrated herewith and which is named "Hypress" by its manufacturer, the L. J. Wing Manufacturing Company, was de-

signed with these facts in view. Its construction is simple and it has about as few moving parts as a blower well could have. It consists of a cast-iron casing in which an eccentric drum revolves; see Fig. 2. This drum carries a steel sliding vane fitted with self-adjusting rollers at its ends which make a practically air-tight contact with the wall of the casing.

The air is compressed during its passage from the inlet to the outlet of the blower. It is said that the efficiency of the blower is unusually high.

These blowers are manufactured for normal capacities of from 80 to 8000 cubic feet of air (actual) per hour at 2 pounds pressure.

Lalor Automatic Stop Valve

This valve has been designed to automatically stop the supply of oil in case of breakage of the oil lines or abnormal flow to the burners. Its action is automatic, closing and remaining closed until it is manually opened.

There is but one moving part to the valve, the plunger, which is entirely inclosed and so protects the valve that it cannot be held in an open position or become clogged by foreign substances in the oil.

In Fig. 2 is shown a sectional view of the valve in an open position. The flow of oil is toward the lift and upon entering the valve body it passes to the inside of the plunger, through the ports shown, and out to the pipe line.

If the pressure in the discharge pipe drops, the spring will draw the plunger down to a position where the port openings will be below the valve seat. With a uniform oil pressure in the pipe the pull of the spring is counteracted and the plunger will remain in the position shown. When the valve has once closed it is necessary to reset it again by lifting up on the hand lever, to which is attached the piston stem, as shown. After the tension of the spring has been adjusted for a certain maximum flow of oil, the valve will operate as soon as the maximum flow is exceeded. This valve is manufactured by the Lalor Fuel Oil System Company, 1326 Chestnut street, Philadelphia, Penn.

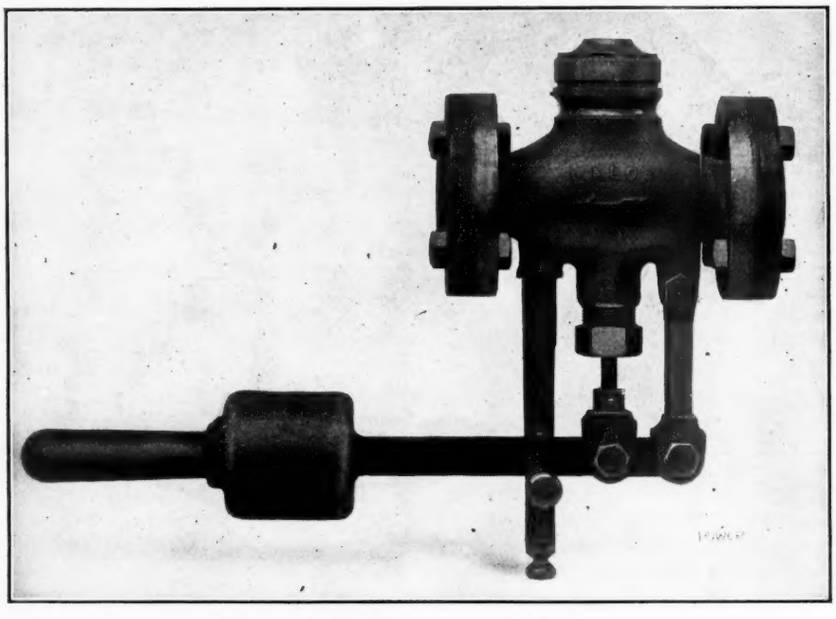


FIG. 1. LALOR AUTOMATIC STOP VALVE

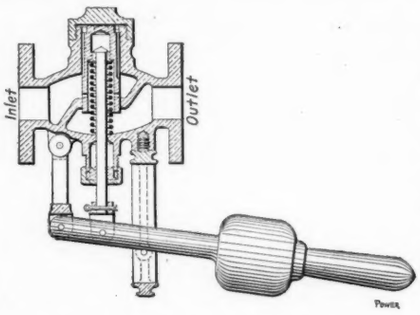


FIG. 2. SECTIONAL VIEW OF VALVE

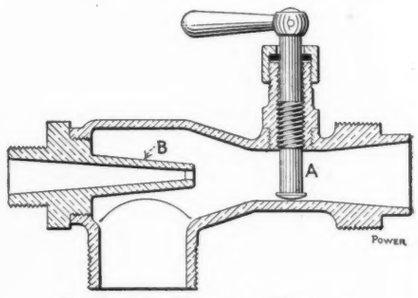
Water Ejector with Priming Attachment

The difficulty of starting up promptly with the ordinary design of water-lifting ejector is claimed to be obviated by the use of the new patent water ejector made by the Penberthy Injector Company, of Detroit, Mich.

This ejector may be operated with any fluid under pressure but it is designed more particularly to be operated with water. It is composed of a casing so shaped as to permit the delivery tube to be formed integral with the main casting without projecting into the suction chamber. This gives an unobstructed passage through the ejector and allows its use for handling sewage that has coarse matter in suspension.

This ejector also finds service within the limits of use of other ejectors and, in addition, can be used to lift liquids from below when operated with water of low or high pressure or with other fluids except gases, but it may be operated with air to handle gases or air. When used lifting from below it has an advantage over the ordinary ejector in that it is provided with a lifting attachment or primer. The primer is threaded into the discharge neck of the ejector and is composed of a screw stem and handle. When priming the ejector, the stem is screwed in so that it extends across the delivery-jet bore, as shown at *A*. The stem in this position is directly in front of the operating fluid which leaves the outlet of the power tube *B*. The stem parts the operating jet and this jet, on account of being parted and broken up, completely fills the delivery-jet bore, so that there can be no back travel of air through the discharge branch of the ejector into the suction branch. A strong partial vacuum is, therefore, readily attained and when the lift is accomplished, the stem is screwed out and free passage is given.

This ejector is made in sizes accommodating the various sizes of iron pipe and hose, and some of the uses to which it is adapted are the raising of thick liquids and sewage, draining trenches where tiling or water piping is being laid, the ejector being operated by water from neighboring hydrants. They are also used for filling spray rig or other tanks, water being furnished to them under pressure by a pump driven by a gasolene engine. In such service, the utility of the ejector is such that 14 gallons of water may be lifted from a depth of 22 feet with a consumption of but 6 gallons by the ejector.



SECTIONAL VIEW OF EJECTOR

Already, many exhibitors have taken space at the power show to be given at the Mechanics Building, Boston, Mass., Apr. 22 to 27, and all firms interested in power-producing machinery are urged to assist in making the coming power show the greatest and most successful exhibition ever held in the United States.

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POWER

Looking Back over the Year 1911

A retrospect of the power field for the year just past reveals great activity in the development and perfection of the steam turbine. With the exception of Tesla's series of disks between which steam passes and causes rotation, nothing new or startling appears; but a number of tests showing remarkable economy have been made and individual units have been increased greatly in size. Close readers of POWER will require no reminder of the test conducted at the Dunston power station of the Newcastle-on-Tyne Electrical Supply Co., where a 6000-kilowatt Parsons turbine showed a thermal efficiency of 76.4 per cent. and developed a kilowatt-hour on 11.8 pounds of steam. The installation of a 27,000-horsepower Curtis turbine at the Waterside No. 1 station of the New York Edison Co. was a notable event, for, at the present writing, this is the largest turbine in the world. The unit, which is the first of three similar machines to be installed, is 35 feet high, covers an area of 297 square feet and weighs 420 tons.

Combination turbines using an initial velocity or Curtis stage followed by Rateau or Parsons pressure stages have continued to make strides in Europe, and are now manufactured by nearly all the companies which formerly built the straight types. The simple-velocity stage replaces a multiplicity of small blades in the initial part of a turbine of the Parsons type and confines the high pressures and temperatures to the steam chest, greatly reduces the length and complexity of the turbine, and diminishes the weight by permitting higher speeds.

Another effort in the direction of reducing the number of stages is that of Patitz. Since the energy in the moving jet varies as the square of its velocity, three-quarters of its energy will be abstracted by reducing its velocity one-half. Instead of getting up a low velocity like Rateau or Zoelly and abstracting it more or less completely at each stage, Patitz gets up a high initial velocity, takes out about one-half of it, and without further reduction restores the high velocity by further expansion, converting this much more energy per stage.

In marine work, turbines designed for high pressure and those utilizing exhaust steam from reciprocating engines have been viewed with increasing favor, and as a noteworthy example of the latter the mechanical equipment of the "Olympic" may be cited. From two 15,000-horsepower triple-expansion engines driving the outside screws the exhaust is passed to a 16,000-horsepower low-pressure turbine on the middle propeller.

In the merchant marine, and particularly in those vessels equipped for passenger service, the high-pressure turbine has made an enviable record, but in naval circles, where cruising at low speeds is common, the turbine has failed to come up to expectations. As a result of the comparative trials of the scout cruisers "Birmingham," "Chester" and "Salem" and the more recent tests of the battleships "Delaware" and "North Dakota," the United States Government favors the reciprocating engine, and, in addition, has decided to try oil fuel in some of its latest battleships.

Reduction gearing, now available in capacities undreamed of a few years ago, promises to do much to reconcile the differences between the steam turbine and the propeller, and to make the steam turbine available in wider fields. As a means toward the same end, the Foettinger hydrodynamical gear may be mentioned and also the electrical method of using a generator and induction motor between the turbine and the propeller. In large powers the electrical losses would not amount to more than 8 per cent. as compared to 2 per cent. for the gearing in perfect condition. On the other hand, the projectors of the electrical method offer a highly increased efficiency of the turbine and a very considerable reduction of the aggregate weight and space, due to the higher speed at which it would be possible to run it.

Even the rolling-mill field, which has always been considered the last and most

secure stronghold of the reciprocating engine, has been invaded by the aid of reduction gearing. The turbine, which was of the mixed-pressure type and installed at the Calderbank Steel Works of James Dunlop & Co., was rated at 750 horsepower and ran at a speed of 2000 revolutions per minute. This was reduced to 70 for the mill and a 100-ton flywheel absorbed the shock.

With the introduction of large turbine units, a corresponding increase in the size of boilers might naturally be expected. The year has witnessed the successful putting into operation of the largest boilers yet constructed, those at the Delray station of the Detroit Edison Co. At the common rating of 10 square feet of heating surface per horsepower, each boiler has a capacity of 2365 horsepower and is capable of caring for a turbo-generator load of 6000 kilowatts regularly and 8000 kilowatts at the peak. In the most stupendous boiler test ever reported, requiring the continuous service of over fifty men for nearly three months, these boilers showed the highest efficiencies ever obtained with bituminous coal. They were in a measure anticipated by a 2500-horsepower unit of Hornsby boilers ordered by the Hartford Electric Light Co. and described in our issue of Feb. 28. Before their installation, however, it was decided to throw up a curtain wall in the furnace and separate the sections, thus dividing the unit into two of 1250 horsepower each.

Accidents to boilers have been numerous, as indicated by reports for the first six months of the year. During this time 272 accidents occurred, including "real" explosions, tube blowouts (of which there is an increasingly large proportion) and blowoff failures on stationary, locomotive and marine boilers. The fatalities total 138 and doubling this number would indicate a death list approximating 250 for the year.

The continued wholesale destruction of life and property in this country from boiler explosions is a national disgrace and warrants every effort which will tend to reduce it. Before much can be done in this direction every state in the union must have adequate license and inspection laws, and these should be as uniform as possible. In this direction the most notable step in advance has been taken by Ohio, where a board of boiler rules practically identical with that of Massachusetts and having similar powers has been appointed. It is to be hoped that other states will soon follow with similar laws which at least possess the virtue of preventing the installation of palpably unsafe boilers even though no steps are taken to eliminate those already in use.

Massachusetts itself has made some important changes in the application for examination and in the appeal therefrom. The horsepower rating of boilers has been altered slightly and a turbine rating appended. These and a number of minor amendments to its boiler rules went into effect the first of the new year.

Bills for the licensing of engineers have been introduced in the legislatures of New York, Connecticut, Rhode Island, Kansas and several other states, but have failed to pass.

Adoption and advancement of these laws, of course, require more from the engineer. He must know his profession thoroughly, and, as a means toward an end, the organization known as the Institute of Operating Engineers was incorporated and held its first convention during the summer. Its work is purely educational and its affiliation with numerous trade and correspondence schools gives the engineer every opportunity to work out his own education under competent guidance.

The tests to destruction of two 72-inch cylindrical boilers by James E. Howard indicate that other factors than those ordinarily considered should be taken into account in determining the safe working pressure of boilers; and continued investigations by this method are likely to have an important bearing upon the design of boilers, especially of the more complicated types.

Other important tests relating to boilers which should be enrolled in the year's work were those conducted by the United States Geological Survey, which tend to show that a solid boiler wall is a better heat insulator than a wall of the same total thickness containing an air space. The loss by radiation forms the basis for this conclusion which is contrary to the general belief.

A notable demonstration in the field of combustion is that of Prof. Bone, who shows that a combustible mixture of air and gas burns upon or below the surface of a porous plate without flame and with great intensity. An application to boiler practice is to inject such a mixture into the tubes of a boiler which are filled with broken refractory material. A boiler 10 feet in diameter and with tubes only 4 feet in length has been recently built for the Skinningrove Iron Co., Ltd., of Yorkshire. The normal evaporation is 21 pounds per square foot of surface and this can be doubled with small loss in efficiency.

Among steam engines the locomobile and Prof. Stumpf's uniflow type have attracted wide attention. The conception of these engines, of course, antedates 1911, but practical development has been made during the year and a great deal of discussion has been published on their relative merits.

In the gas-engine field steady, conservative progress has been made, but more particularly in Europe than in the United States. Engines of the four-stroke-cycle type are being built to develop 1500 horsepower per cylinder and 2000 horsepower working on the two-stroke cycle. It is in the Diesel engine that greatest progress has been made; the development has been phenomenal. This type of engine is seen everywhere in Europe and is much more common than any other recent type of prime mover. Several large ships have been fitted with Diesel engines and it is current report that the German navy is at present installing 10,000 horsepower of this type of engine in one of its new battleships. In Switzerland, multicylinder units of 2000 horsepower are in active service and, before long, single cylinders of 1000 horsepower may be expected.

The Grine crude-oil gas producer recently installed in Los Angeles, Calif., is worthy of mention. Its principle of operation differs from the ordinary in that the oil is atomized in the upper part of the generator and is passed downward through a bed of incandescent coke in the bottom of the generator where the heavy hydrocarbons are broken up and the tarry content fixed. Using crude oil costing 2.3 cents per gallon, it is claimed by the inventor that the same amount of power will be developed that the ordinary engine develops per gallon of distillate costing 7 cents per gallon in the same locality.

Electrical apparatus has become so well standardized that radical chances are not to be expected. Progress has been made, however, and it is most ap-

parent in the constantly increasing size of electrical machinery and apparatus. Motors up to 5000 horsepower are becoming common and at McCall's Ferry the 10,000-kilovolt-ampere transformers but recently installed are reported to be the largest ever built. In mine-hoist and rolling-mill work the electric drive has made a safe entry in the face of conditions which were previously considered prohibitive.

A recent example of the modern tendency of replacing the piston by machines employing rotary motion is the rotary air compressor, a machine exceptionally light and compact when compared to the immense blowing tubs now in common use. During the year one of these blowers was put into service at Oxford Furnace, N. J. It has a capacity of 22,500 cubic feet of air per minute, which is delivered at a normal discharge pressure of 15 pounds per square inch. In Europe pressures as high as 140 pounds have been attained.

While on the subject of gas the Thomas electric meter should be mentioned as an ingenious instrument which seems to promise a solution of the difficult problem of measuring gas and air in large quantities with considerable accuracy.

During the year there has been a great deal of agitation on governmental control of water power and no doubt the public conference held under the auspices of the power-transmission section of the National Electric Light Association did a great deal of good, as both sides of the question were thoroughly discussed before Secretary Fisher, representing the government. At the time of the meeting the government had not formulated any definite policy on the control of water power, but since then the secretary has made a tour of the West and has visited Alaska to look over the government coal lands, so that the conservation movement on both coal and water should receive the intelligent attention required from the government for a successful solution of these problems.

During the year there have been lost to the power field a number of prominent workers. In the first month of the year Louis R. Alberger, who was president of the Alberger Condenser Co., passed away. His life work as well as that of his father before him had been associated with condensing apparatus. He was soon followed by William B. Mason, president of the Mason Regulator Co., and inventor of numerous valve and engine appliances. Charles W. Hunt, president of the C. W. Hunt Co., and a former president of the American Society of Mechanical Engineers, at his death in March left an enviable record in the development of conveying and hoisting machinery, industrial railways and kindred lines. James C. Bradford, who built the boiler for the "Monitor" during the Civil War, died in April, and a few months later James C. Brooks, president of the Southwark Foundry & Machine Co., and George F. Hughson, holding a similar position with the Hughson Steam Specialty Co., passed away. Henry W. Bulkley, inventor of the first practical injector condenser, died in November, and during the latter part of the year the Westinghouse Co. of Pittsburg was unfortunate in losing two of its prominent officers: Robert Mather, chairman of the board of directors, and George W. Hebard, acting vice-president.

Prof. Stumpf's Criticisms

The discussion which has arisen between Prof. Stumpf and Mr. Heilmann, as a result of the latter's paper dealing with the heat efficiency of reciprocating engines, unfortunately has resolved itself into a bipartisan controversy regarding the relative merits of the Stumpf uniflow engine and the Wolf locomobile.

The tests forming the basis of Mr. Heilmann's original paper were made for the purpose of determining the influence of primary and secondary superheating and of vacuum upon the steam consumption of the locomobile engine; also, a careful study of the heat losses in both this type and the uniflow engine was made. From a purely technical standpoint the results form a valuable addition to the data already available upon the subject.

In conclusion, however, Mr. Heilmann offered some criticisms of the uniflow design, some of which, in view of the tests, seemed warranted; but he unwisely attempted a comparison between this type and the locomobile design, favoring, of course, the latter.

These criticisms, although mild, appear to have incited Prof. Stumpf to make a savage attack upon the paper, with an attempt to discredit its value by questioning Mr. Heilmann's intentions. In this he does not confine his attentions to the points at issue, but goes further and attacks the whole locomobile design. He says in this connection: "Separated from the boiler, the Wolf engine must be designated as the worst, because it has the largest clearances and the largest detrimental surfaces of all comparable engines, and in addition a combined inlet and outlet passage." However, the mere fact that this engine is placed in the uptake from the boiler precludes the necessity of many of these features, and it is manifestly unfair, if not ridiculous, to attempt to judge it separately from the boiler.

It seems most unfortunate that investigations of this character should not be accepted solely upon their scientific value regardless of personal and commercial motives. However, as is often the case, discussions often bring out more important points than those contained in the original statements. We are glad to see that some of our readers have appreciated the importance of the subject and have shown a disposition to discuss it.

One lesson to be drawn from the tests to destruction of a large horizontal return-tubular boiler by James E. Howard, as described on page 845 of our issue of Dec. 5, is that something more than the diameter, tensile strength and efficiency of the riveted joint must be taken into account in figuring the allowable pressure upon a boiler of this type. When the pressure applied reached 270 pounds, the cast-iron manhole frame was fractured across its center. If this had happened under steam pressure, it might have resulted in the destructive explosion of the boiler, and yet at the allowed pressure of eighty-five pounds it affords a factor of safety of slightly over three, whereas, figured in the usual way, the factor of safety was around five. It is true that the pressure was progressively reduced by the inspection and insurance company until at the end of twenty-seven years it had gotten down to fifty pounds; but it is not likely that the manhole frame was materially stronger at the commencement of the service of the boiler than it was at the end.

If you wanted to know whether the name of the Stirling boiler is spelled with an "i" or an "e," you could not find out from Professor Jacobus' paper on the Delray tests.

Readers with Something to Say

A letter good enough to print will be paid for. Ideas, not mere words, wanted

A Case of Cylinder Distortion

A remarkable case of cylinder distortion, and the builders' remedy, which came under my notice, is illustrated by Figs. 1, 2 and 3.

This engine had a 12x20-in. cylinder and ran 232 r.p.m., developing about 100 horsepower.

The cylinder, Fig. 1, had been in use a number of years and was mechanically faultless, the only defect being its excessive clearance.

The builders of the engine designed a cylinder and exhaust valve whereby the clearance was reduced nearly one-half. They also changed the steam side, which made the new cylinder casting the shape of Fig. 2.

When the work of installing the new cylinder was finished and the engine

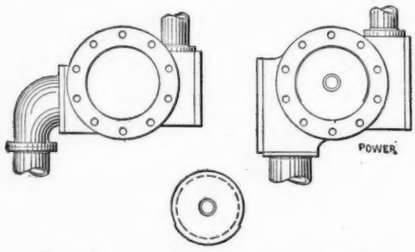


FIG. 1. FIG. 3. FIG. 2.

started up with steam at 40 lb. pressure just to see that everything was clear, also to prove the adjustment of the valves by the indicator, everything was found to be satisfactory.

Before putting the engine at its regular work, I was careful to heat the cylinder as much as possible before starting time, and before and after starting up I gave the cylinder an extra supply of oil.

After running nicely about half an hour with the regular steam pressure of 85 lb., the speed slowed down, but after a minute gradually came up again; this action was repeated several times during the first hour's run.

After the day's run I took the cylinder head off and the condition of the cylinder was a surprise to me, as it was roughed up the whole length, on both sides, they having drawn in and gripped the piston. The top and bottom of the cylinder had evidently gone outward, the cylinder becoming elliptical.

The counterbore was round when the cylinder cooled off; therefore the destructive distortion may be attributed to the change of temperature due to the difference in the pressure of the steam at 40 and 85 lb., which is less than 50 deg. The primary cause was the distribution of the metal in the different cylinders. The cylinder was returned to the shop, where it was rebored and a new piston made for it, Fig. 3.

This piston was of the solid type and packed by two narrow rings made in one piece and sprung into grooves near each end. It was first turned in the lathe to the exact diameter of the cylinder and then around two-thirds of its circumference it was reduced about $\frac{1}{32}$ in. by planing it on centers. The turned surface of the piston bore on the bottom of the cylinder through about 120 degrees.

The packing-ring joint was kept at the bottom of the cylinder by a pin set in the grooves between the ends of the rings. Here the joint is packed by the contact of the piston itself with the bottom of the cylinder so that steam cannot blow from either end of the cylinder past one ring to the other.

Cylinder No. 1 was again displaced by No. 2 with good results and gave no further trouble.

J. W. PARKER.

Clinton, Mass.

Timely Discovery of Serious Lap Crack

In the forenoon of Dec. 2, a lap crack was discovered in the rear course of the boiler owned by O. S. Cook, a box manufacturer, of West Fitchburg, Mass. Engineer W. F. Dennihan noticed a small amount of steam coming up through the brickwork the day before. As a brace rivet had been calked there a short time before, he thought that this rivet was leaking again, and did not give it much attention. Saturday morning, Mr. Dennihan noticed that the leak was increasing and immediately decided not to run until noon, but to lower the pressure at once and investigate. (This was in opposition to the wishes of the owner, who wanted to run until noon.)

After tearing off the brickwork, a crack 5½ in. long was found coming through the outside of the lap at the inside edge of the rivet heads. The inspector for the insurance company was called and he immediately condemned the boiler. Taking a heavy hand hammer the inspector pounded along the joint, beside the rivet heads, and the crack continued to open up for a distance of about 30 in., which was as far as the brickwork had been removed at the time.

This boiler was built 11 years ago. The dimensions are: Shell, 48 in. by 14 ft.; shell plates, $\frac{5}{16}$ in.; heads, $\frac{7}{16}$ in.; tensile strength, 55,000 lb.; the boiler had fifty-two 9-in. tubes.

The joint is a double-riveted lap; the pitch of the rivets is 2¾ in.; the efficiency, 72 per cent. The pressure allowed was 90 pounds.

It is said that the former state inspector intended to cut the pressure to 78 lb. on account of the age and type of the boiler. When this was made known to the owner, the boiler was given to an insurance company; this company allowed 90 pounds.

LESTER A. FITTS.

West Fitchburg, Mass.

Governor Troubles

The governor of an automatic slide-valve engine went to pieces suddenly. The fragments of the weight arm severely injured the engineer, smashed the switchboard and damaged the building.

The design of the governor was blamed for the accident and a new one with lighter parts was installed. When the engine was started up the new governor seemed unable to handle the valve, as it moved the valve gear in jerks even after the spring was adjusted for the proper speed.

I took the valve gear apart and found that the yoke, Fig. 1, which connects the valve rod and valve had not been fitted to hold the valve horizontal and parallel to its seat. It was, therefore, binding

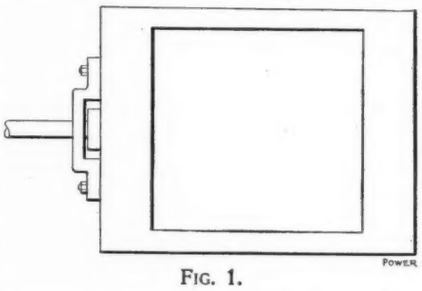


FIG. 1.

between the seat and the pressure plate and also on the top and bottom. I fitted the yoke so that the valve could move freely, and the governor gave satisfactory regulation.

Another engine showed similar symptoms in regard to valve motion and it was found that the reinforcing rib running through the center of the head-end steam ports was cracked and had risen about $\frac{1}{100}$ inch above the surface of the valve seat. The valve would strike

the projection, making it impossible to run smoothly.

As the cylinder barrel was strong and the steam chest and cover heavy enough to make the cylinder safe, I drilled a ¾-inch hole into the crack, as shown in Fig. 2, screwed in a stud about 1¼ inches long and surfaced 1 inch of the valve seat with file and scraper. The engine is now running without signs of trouble and uses less steam than before.

In another case the engine showed an inclination to race, and during such a

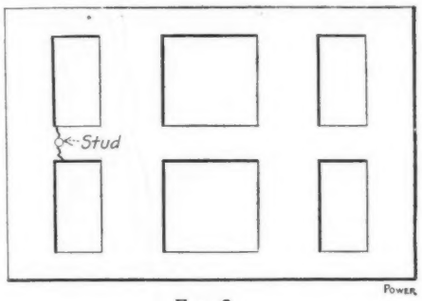


FIG. 2.

spell snapped the eccentric rod. When the eccentric straps were removed and examined it showed that they had a rib cast in to hold the babbitt, as shown in Fig. 3. After the babbitt had worn down to the rough cast iron, the straps began to bind and cut the eccentric, which was moved back, giving more steam and causing racing. When the engine attained an excessive speed the governor weight flew

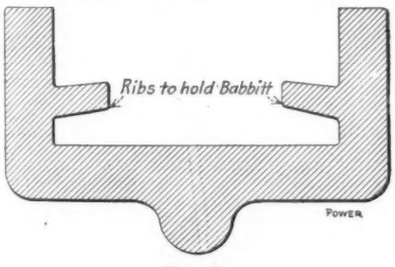


FIG. 3.

out with a jerk, throwing the eccentric forward and snapping the rod.

A similar accident happened in another case when the eccentric had become dry and began to cut.

A four-valve engine would race when running light and would slow down to a stop when the load was thrown on. The engineer blamed the governor, which was worn badly. A machinist took all the parts to the shop, where all links and pins were refitted and relined. I was sent to reassemble the governor and try it. There was no load and the engine began to race with the governor set far below its normal speed. The owner of the plant, seconded by the engineer, claimed that the governor was not assembled right, due to some parts being marked wrong when the governor was taken apart. I was quite sure about my work and, noticing that the engine would not start from the crank end, charged that somebody had been tampering with the valves. I had no indicator with me and therefore removed the valve bonnets and found that the head-end steam valve was turned upside down. The trouble was now explained; the engine always had full steam at the head end, which was enough to send it flying without load and with but little power from the crank end, as there must have been considerable back pressure before, and a decided drop in the steam line after the head-end exhaust valve gave full opening; that exhaust was also late. The valves were properly set and the governor performed well. There had been a change of engineers.

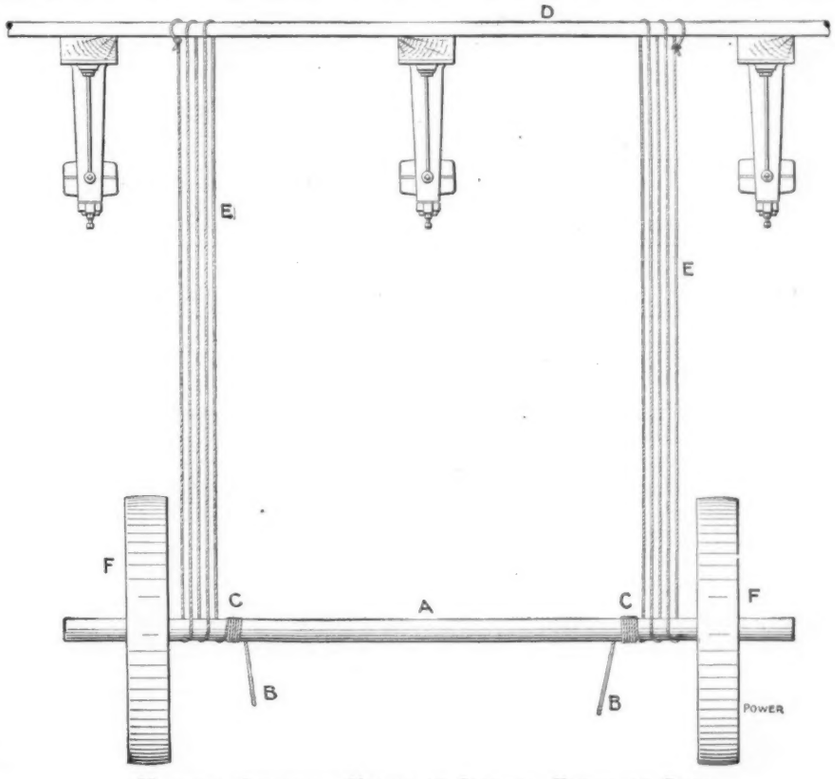
Irregularities in speed of an automatic engine are not always caused by faults of the governor and it is well to examine the valve gear and valves.

H. WERNER.

Chicago, Ill.

Shaft Hoisting Wrinkle

I had a 12-foot length of 4 7/16-inch shaft with two 5-foot pulleys on it, weighing in all about 1200 pounds, to put up in one piece. As suitable tackle had been sent but miscarried, the job was done as shown in the sketch. It was a new multiplied-strength application of an old idea and is much superior to the old roll-up on a single run of rope.



HOISTING SHAFT BY MEANS OF SEVERAL TURNS OF ROPE

As can readily be seen, by turning the shaft *A* by means of its pulleys *F* and pulling hard at rope ends *B* the shaft was easily raised, as the takeup was cared for by the leads *E*.

Having the shaft *D* free to revolve, and occasionally striking the rope leads *E* with the hand to help equalize the strain between them helped considerably.

CHARLES HERRMAN.

New York City.

"Ammetering" an Air Compressor

The compressor in question was a two-cylinder, double-acting machine, belt-driven from a motor. A controlling device held the suction valves open when normal pressure was reached in the receiver.

The average horsepower consumed by the machine had been determined by wattmeter readings extending over a period of two weeks. The object in applying an ammeter to the motor was to determine the power used when running idle and under load. The interesting part of the application was that the power required when running idle was 20 horsepower where it should have been around 7 or 8 horsepower.

An investigation showed that the controlling device was not working on one cylinder and that this cylinder was working steadily all day; as a result, the other was having a rest most of the time. A few minutes' adjustment had the controlling device back on the job. All of which goes to show that a little experimenting often leads to unexpected results.

JOHN BAILEY.

Milwaukee, Wis.

The Scotch Marine Boiler

There appear from time to time discussions on boiler construction, mainly referring to the riveting, bracing and style of joint to be used, thereby giving the impression that these are the main features to be looked into when purchasing boilers.

Many engineers and owners think the return-tubular boiler is the only type that should be installed. I think this opinion is mainly due to lack of knowledge of other types.

I have had a number of years' experience with the return-tubular boiler and have concluded it is the least really improved type of boiler in general use, everything considered.

Safety is the most important of all points to be considered, and this is the weakest point in the return-tubular boiler. Why is it more liable to explosion and other troubles than other types? Because the most important part of the boiler (the outside), being of large diameter, is subject to excessive heat, caused by the collection of impurities between steel and water and extreme changes of temperature. Then, consider the minor faults. The blowoff pipe must be covered or it is very dangerous and when covered is not always easy to examine. The water column usually is too far from the boiler and has too many bends. I have seen the lower pipe as long as 75 inches.

It takes too long to cool a return-tubular boiler, as it has so much brickwork around it.

While I have never given the different types a test for circulation, I have decided that the return-tubular boiler has the poorest circulation of the boilers in general use. This is due to the even distribution of the applied heat.

While I am not an agent of any boiler-making firm, I am a strong advocate of the Scotch marine, internally fired boiler for stationary use. If engineers and owners would study boilers more and the steam-engine indicator and the condenser less, I think it would be time well spent.

The Scotch marine boiler is built upon scientific principles and designed to suit requirements. It is not subjected to violent explosions as the inside parts are the weaker and show signs of distress first. If anything should give way, the result would not be of a disastrous nature. Some authorities claim that this type has a poor circulation. It cannot have a poorer circulation than the return-tubular boiler, as the heat is so evenly distributed to the water.

A representative of a return-tubular boiler-manufacturing company advised me never to recommend a Scotch marine boiler to prospective buyers, his excuse being, "They are fierce when they get dirty." Is not any boiler fierce when it gets dirty?

For economy the Scotch marine heads the list when properly handled, especially in long runs. The water and steel are all that have to be heated. The loss of heat is only up the stack, if the boiler is insulated properly. The cost of upkeep should be low as this type of boiler is simple, convenient and has few parts to give trouble. It does not require over four to six hours to cool sufficiently for it to be comfortable to work inside, and it does not occupy nearly as much space per unit of capacity as other types. They have no large, hot combustion chamber to be cleaned on hot summer days.

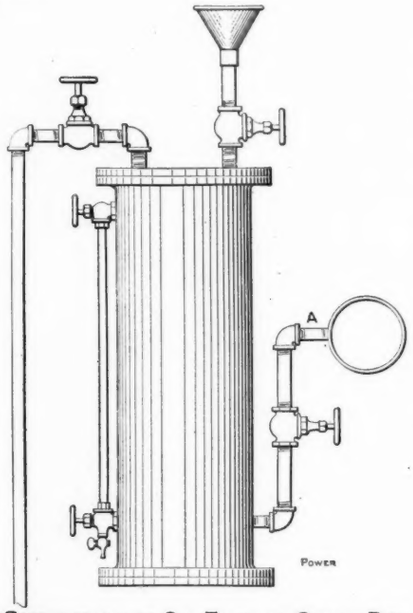
I consider an investment in a good internally fired Scotch marine boiler a good dividend payer.

RAY GILBERT.

Virginville, W. Va.

Oil in Steam Pipe

The accompanying sketch shows the connections to the tank of an oiling system. The tank is located on the rear of the boiler setting and connected to the lubricators on the engines, which were about 6 feet lower than the oil-supply tank.



CONNECTION OF OIL TANK TO STEAM PIPE

When I took charge of the plant, I found that considerable oil was working out of the flanges on the live-steam line and that the oil consumption was excessive. I could find no trace of oil in the boilers. I disconnected the small steam pipe at *A* and extended it up about 15 feet and connected it to a live-steam line on the floor above. It was a direct and independent line from the main header over the boilers. This stopped the trouble, but how did the oil get into the live-steam line?

G. A. ROBERTSON.

Louisville, Ky.

Piston Trouble

In the equipment of a steam power plant there are two 31 and 66 by 48-in. cross-compound engines running at 90 revolutions, each directly connected to 1500-kw. generators.

The high- and low-pressure cylinders both have tail roads and floating pistons. As shipped by the makers, the pistons

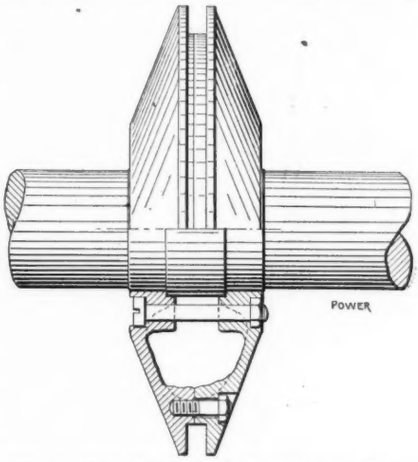


FIG. 1. THE PISTON AS ORIGINALLY MADE

were held together at the outer edges by twenty-four $1\frac{1}{8}$-in. shoulder studs and at the rod there were twelve $1\frac{1}{8}$-in. mild-steel bolts 9 in. long. The piston was counterbored on both sides to receive the heads and nuts of these bolts, the construction being shown in Fig. 1.

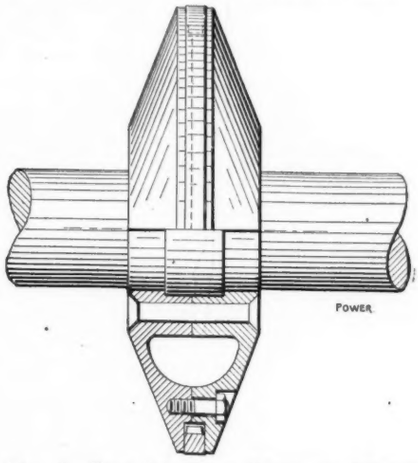


FIG. 2. THE IMPROVED FORM OF PISTON

When the plant was put in service I started the machinery cautiously and took several weeks to get up to the full degree of superheat. One day, after the steam temperature had reached about 450 deg. and everything was running smoothly, there came knocks at the rate of 90 per minute from the high-pressure side of No. 1 engine; then the noise stopped as suddenly as it had begun. Another unit was put into service and a hunt for the cause of the trouble began. External examination showed a badly twisted exhaust-valve stem, and when the cylinder head was taken off the cause

was plain. A follower bolt had snapped off in the threads and while the nut was being hammered between the piston and the cylinder head the bolt had been swept into the exhaust port and caught by the valve as it started to close. Something like a dozen blows had been struck, and it spoke volumes for the workmanship of the engine that it could be used as a steam hammer without serious injury.

The nut and bolt were found in the receiver, but in such a shape that I could tell nothing about the cause of the break, so I assumed it to be a case of poor material and replaced it with a Norway iron bolt.

Shortly afterward another one broke, and I replaced them all with Norway iron. Then one of the Norway bolts went and I decided that it was the concentration of the stress at the root of the threads that was doing the damage and I had all of the bolts turned down to ⅞ in. for a space of 3½ in. at the middle.

Then some more broke and I was forced into the conclusion that there must be an unusual and unallowed-for stress in those bolts and began to hunt for it. From the shape of the halves of the piston it appeared to me that the temperature changes which would take place between 70 and 450 deg. would cause a distortion sufficient to stress the bolts beyond the elastic limit. The matter was taken up along these lines with the manufacturers, who furnished two new pistons in which the 1⅛-in. bolts were replaced by 1½-in. rivets. Both these features added wonderfully to the rigidity of the construction and there has been no return of the trouble. The piston as replaced is shown in Fig. 2.

LINDSAY DUNCAN.

McGill, Nev.

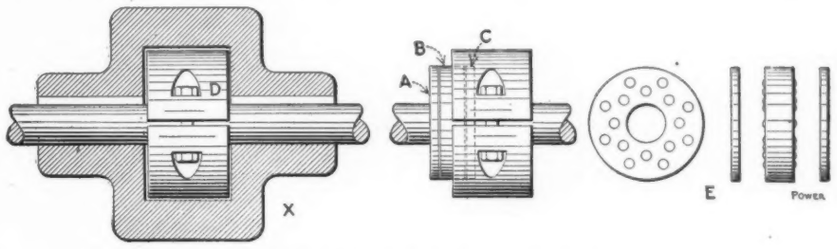
Ball Bearing Thrust Collar Eliminated Heating Trouble

A thrust collar which gave considerable trouble by heating was employed on the shaft of a motor and turbine pump, which ran at a speed of 1800 revolutions per minute.

Sulphur, graphite, castor oil and various grades of lubricating oil were used, but none of them prevented the heating. Finally it was determined to try to insert a ball-bearing thrust collar.

The collar was removed from the recess in the bearing, placed in the lathe and countersunk a depth equal to one-half the thickness of the ball-bearing thrust collars, as shown at *B* and *C*. It was then only necessary to cut enough away from the thrust end of the box to admit a thin steel ring plus half the thickness of the thrust collars which were placed on the shaft, as shown at *A* and *B*. The cap was treated in like manner.

The steel rings *A C* and the ball-bearing ring *B* are solid. After removing the shaft part way out of the bearing, they were put in place, as shown at *X*. The split thrust collar *D* was then put in place, as shown. This was an easy matter, since the countersink was a trifle larger than the diameter of the rings.



THRUST COLLAR FOR BALL BEARING

Upon testing the job it was found that the shaft could be rotated by one hand, whereas before making the change it was about all a man could do to turn the shaft by means of the coupling. When the motor was started no further heating occurred, the bearing remaining practically cold after a prolonged run. The two rings and ball-bearing plate and placing of the 20 balls are shown at *E*.

WILLIAM KAVANAGH.

New York City.

Home Made Damper Regulator

Will some of the readers of POWER tell me how to make a damper regulator at a small cost and without going to a machine shop, illustrated with drawings, if possible?

A. SEIMES.

Atlantic City, N. J.

Cause of Boiler Explosions

Most any steam engineer knows that when getting up steam he should always open a valve connected to the boiler to let the cold air escape.

I have seen three boiler explosion and none had been freed of air. The first was a portable boiler. The engineer was getting up steam ready to start at 7 a.m., and the glass was half full of water which ran freely out of the second try cock. Steam was raised very slowly and the gage showed about 40 pounds pressure when the engineer opened the steam valve on the injector. A little air came first, followed by steam, and almost at the same time the boiler exploded.

The second explosion was that of a boiler in a small mill. No valve had been opened until the engineer opened the throttle to warm up the engine, when there was an explosion which killed one man.

The third explosion happened to one of a battery of eight boilers. The boilers were all shut down and washed out. The two small boilers were filled with cold water and a fire started under them about 9 a.m., to get up steam for the pumps and machine shop. About 1:30 p.m. there was enough steam to start one of the pumps to fill a tank, but as soon as the pump was started, both ends of No. 8 boiler blew out, killing two men and wrecking things in general.

I have been engineering for 15 years, both marine and stationary, and I have come to the conclusion that not one boiler in 20 blows up because of low water.

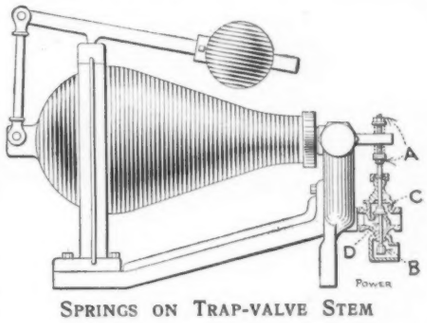
D. M. FRASER.

Wallaceburg, Ont., Can.

Springs on Trap Valve Stem

Having had some trouble with a large return trap, due to the release-valve stem breaking, I adopted a scheme which has entirely eliminated the trouble.

The action of the trap on filling is to force the valve *B* against its seat and on discharging the valve *C* was forced against its seat. If the nuts *A* were not exactly adjusted, either an unnecessary strain was put on the valves or they did not seat properly. Sometimes the stem would break at *D*.



SPRINGS ON TRAP-VALVE STEM

To overcome the trouble two small springs were wound and placed between the lever on the bowl and the two adjusting nuts *A*. This allowed the valves to cushion easily and after 18 months' service the trap has not once required attention.

GEORGE H. HANDLEY.

Newburgh, N. Y.

Rendered necessary by the growth of the demand for electricity from the municipal plants, the authorities in Birmingham, England, will erect an additional central station to cost about $1,216,625.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Dry Back Marine Boiler

In POWER for October 31, Mr. Fenwick makes inquiry as to the suitability of the internally fired or Scotch boiler as adapted to stationary use, for continuous service of about three months, and also as to the sizes in which the units are built.

Answering the last question first, this type of boiler is made in any size from 75 to 300 horsepower or even larger, and for all pressures up to 175 or 200 pounds, with one, two or three furnaces, depending on the size.

As to their suitability for a three-months continuous run, local conditions will govern that, as it depends almost entirely on the quality of the feed water and the temperature at which it enters the boiler.

If the water does not contain any great amount of scale-forming materials and is heated to 200 degrees Fahrenheit or better, Mr. Fenwick should not experience any difficulty in operating such a boiler under reasonable conditions for three months, or even longer, and by using the blowoff about three or four times a day for a few seconds, preferably when the load is nearly or all off, considerable of the impurities can be removed.

If the water is very bad, his best way would be to install a live-steam purifier (with an auxiliary open heater), which can be cut out and cleaned in half a day at any time during the run.

If these boilers are fed near the top with comparatively cold water, the circulation is poor. The feed water should enter the top of the boiler, pass down between the furnaces at the front end (or beside it if only one furnace is used) and discharge into the bottom of the boiler with the pipe looking toward the back head and about a foot from the bottom. See that the feed pipe is well braced inside the boiler.

The dry-back Scotch boiler is quite common in stationary practice generally and is very satisfactory, all things considered. It is self-contained, easily cleaned and will stand considerable forcing if necessary. The water column should be connected up with good liberal piping, the crosses plugged with brass plugs instead of elbows to facilitate cleaning.

Cover the boilers with at least 2 inches of good magnesia covering and it will stay on the job as long as any boiler made, without cleaning.

GEORGE H. WALLACE.

Racine, Wis.

Charles Fenwick, in a recent issue, asks whether the internally fired, dry-back type of marine boiler, commonly called "Scotch" boiler, gives much trouble due to poor circulation.

With boilers of this type it is common practice to use a pump to circulate the water in the boiler when getting up steam and on some boats the pump is run continuously.

The writer has operated boilers of this type and found no trouble from this cause when the feed water is piped into the boilers as shown in the two views of Fig. 1.

WILLIAM E. FRANCIS.

Lynn, Mass.

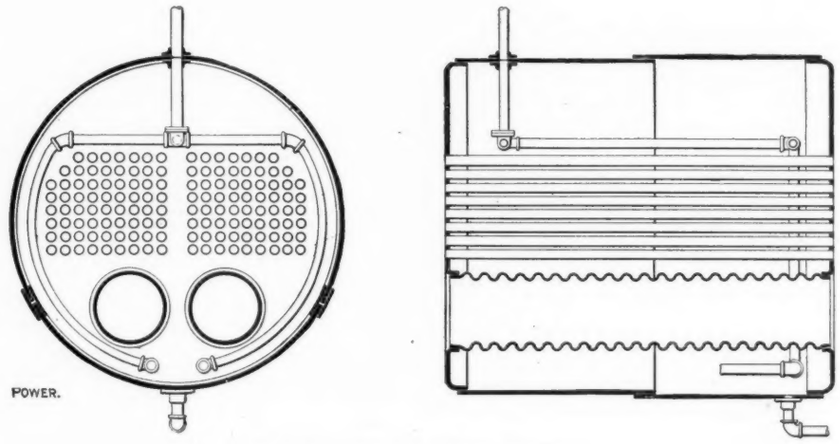


FIG. 1. FEED-PIPE ARRANGEMENT

In reply to Mr. Fenwick's inquiry in the October 31 issue, I would say that the dry-back marine boiler, or the continental boiler, as it is better known, is extensively used in small plants. It gives good service, especially on long continuous runs. The principal trouble experienced with this type is poor circulation. This may be overcome to a large extent by the simple piping arrangement shown in the sectional view, Fig. 2. The piping shown is extensively used in marine work for overcoming poor circulation.

A still better arrangement is to have the boiler-feed pump so connected that when required it will pump the water from the lower part of the boiler into the upper part, thus forcing the circulation. The circulation is, of course, the worst when first starting up. It is at this time that the pump is most useful. As soon as enough pressure has been developed the pump is started and by thus mechanically circulating the water conditions are greatly improved.

A boiler with a corrugated furnace flue should be selected by all means as the straight flue is more prone to develop leaks. The boiler should be covered with a thick coat of some good insulating material, not only because greater efficiency will be obtained but also because trouble with leaking girth seams will be minimized. With a good covering, the expansion and contraction strains are reduced

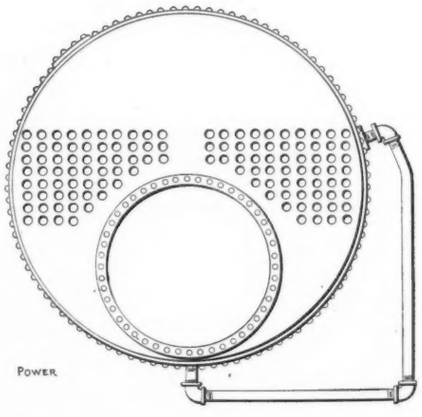


FIG. 2. ARRANGEMENT FOR IMPROVING CIRCULATION

because both sides of the shell are kept at a more nearly equal temperature.

This type of boiler will stand much hard work if properly handled and it is capable of producing excellent results.

C. R. MCGAHEY.

Baltimore, Md.

Unequal Port Opening

In the November 14 number, Mr. Mueller states that he cannot get equal port openings of the valve on a traction engine. Before trying to make the port openings equal, Mr. Mueller should make sure that the design of the engine will permit of this being done without disturbing the equality of the points of cutoff.

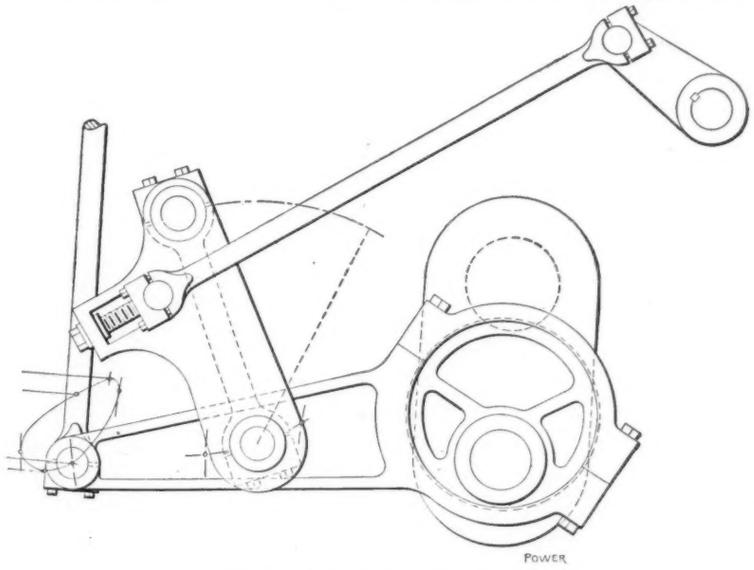
I operate a Case traction engine and the valve on this engine has a $\frac{3}{32}$-inch lead at the crank end and no lead at the other. I know another make of engine which requires a $\frac{1}{16}$-inch lead at one end and a $\frac{5}{16}$-inch at the other.

Some good traction engineers pay no attention to lead whatever when setting the valves. They go entirely by the point of cutoff.

P. C. FORGARD.

Lake Preston, S. D.

Referring to Mr. Mueller's inquiry in the Nov. 14 issue, I will say that while I was serving aboard the U. S. cruiser "Chicago," I had an opportunity to become familiar with the valve-gear of the main engines. This gear was of the See Marshall radial design. The gear is designed to give more power on the upstroke so as to compensate for the weight of the reciprocating parts. No doubt



THE SEE MARSHALL RADIAL VALVE GEAR

the gear on Mr. Mueller's engine was laid out with the same end in view.

CHARLES W. ROOS.

New York City.

I have given the diagram shown by Mr. Mueller in the Nov. 14 issue some study and I do not see why, if all parts have been replaced and any new parts that may have been made were made the same as the old parts, the valve travel should not be correct.

This is the Hackworth gear and it is very simple in design. The link pivot should be on a straight line with the center line of the main shaft, and a distance from the center of the shaft equal to the distance from the center of the eccentric to the center of the link-block pin. If the point where the valve stem connects to the eccentric is correctly located, the reverse lever may be thrown from full gear ahead to full gear back and not move the valve at all in either direction. If adjustments are made so that these conditions are obtained the gear is correctly set.

If the lead is made equal on both ends, the cutoff cannot take place at the same point in both strokes on account of the angularity of the connecting-rod, which is greater with a short rod. I think the valve motion was designed to give equal steam distribution and, if the adjustments are correctly made, no trouble will be experienced with the running of the engine as the difference in port opening was made so as to overcome the difference caused by the angularity of the rod.

ERNEST BRONG.

Mt. Vernon, Ohio.

Centrifugal Pump Speed

N. C. Hurst, in POWER for Nov. 14, on page 751, in criticizing an article by T. W. Holloway in a preceding issue, states that a mathematical analysis will show that the rim velocity of a centrifugal pump runner working against a head h should be theoretically $\sqrt{gh}$, not $\sqrt{2gh}$.

The centrifugal force acting on a body whose weight in pounds is W, linear velocity $= v$ feet per second, at radius r in feet is

$$F = \frac{W}{g}\frac{v^2}{r} = \frac{W}{r}\frac{v^2}{g}$$

Now Mr. Hurst says that if $W = 1$ and $r = 1$, $F = \frac{v^2}{g}$, which is true. But why restrict the formula to those values? It is just as true for any other values of W and r. If W and r are given such values that $W \div r = 1 \div 2$, or so that $W \div r = 3$, one could write

$$F = \frac{v^2}{2g}, \text{ or } F = \frac{3v^2}{g}, \text{ etc.}$$

The flaw in the argument is that he says that this force F is equal to the head h. In other words, a force of, say, 10 lb. is equal to 10 ft. of water. In order to bring in the relation between the two a pressure must be had in terms of unit area, for 2.3 ft. of water equals 1 lb. per square inch. In order to get this relation a definite amount of the water must be considered in order to get this centrifugal force per unit area.

Consider a small elementary prism of water extending from the axis of rotation to the outer rim of the runner, whose cross-section area is A and whose length is r; a volume of Ar is obtained. If p = pressure in pounds per square foot and w = weight of 1 cu.ft. of water, one may write

$$W = wAr, \text{ and the mass} = \frac{wAr}{g}$$

Now the acceleration must be the acceleration of the mass center which is at a distance of $r \div 2$ from the axis. Hence for the square of the velocity divided by the radius must be written

$$\text{Acceleration} = \frac{\frac{v^2}{4}}{\frac{r}{2}} = \frac{v^2}{2r}$$

Thus

$$F = \frac{wAr}{g}\frac{v^2}{2r} = \frac{wAv^2}{2g}$$

But

$$F = p_1 A - p_0 A$$

where

p_1 = Pressure at radius r;
p_0 = Pressure at center.

Therefore,

$$p_1 - p_0 = \frac{wv^2}{2g}, \text{ or } \frac{p_1}{w} - \frac{p_0}{w} = \frac{v^2}{2g}$$

But since $p \div w$ = pounds per square foot $\div$ weight of 1 cu.ft. of water which equals a head in feet of water,

$$h = \frac{p_1}{w} - \frac{p_0}{w}$$

Therefore,

$$h = \frac{v^2}{2g}$$

An actual centrifugal pump depends for its action upon other forces than centrifugal forces, though the latter is an important factor. Therefore, the above holds true only for the case where no flow is taking place, for then only are investigators concerned with centrifugal forces alone. As soon as flow takes place, other factors come in, and it is possible to get a head greater than the centrifugal head alone. However, some pumps have a falling characteristic so that the head continually decreases as

the flow increases. The other type of pump gives an increase in head for small values of discharge and then the head decreases again, and for the conditions where the pump gives its best efficiency the head is usually less than the shutoff pressure.

A complete theory of centrifugal pumps which considers all factors will show that if no flow takes place a centrifugal head of $\frac{v^2}{2g}$ is had, and other items will give a maximum head input of

$$\frac{v^2}{g} = 2\frac{v^2}{2g}$$

But complete theory will show likewise that there is a loss of $\frac{v^2}{2g}$, so that the theoretical head output is the centrifugal head

$$h = \frac{v^2}{2g}$$

as stated by Mr. Holloway. A good treatment of this subject will be found in L. M. Hoskins' "Hydraulics." It is too long to give here.

Therefore, both by theory and practice, the shutoff head of a centrifugal pump will be very nearly

$$h = \frac{v^2}{2g}$$

When the pump is actually delivering water at about its best efficiency the head is usually somewhat less than this.

R. L. DAUGHERTY.

Ithaca, N. Y.

Float Pump Control

The device described by C. S. Runion in the Nov. 7 issue is neat and effective looking. There is one point which I think might improve the sensitiveness of the control, and that is to replace the beam center bearing and journal with a case-hardened steel knife edge and surface. The impromptu roller bearing described might quite easily get jammed or otherwise "stuck up" at a critical moment and possibly with critical results.

JOHN S. LEESE.

Manchester, Eng.

A Vacuum Puzzle

In the plant where I am employed there is a 500-horsepower Corliss compound engine driving automatic looms, a work which requires the best of speed regulation. A short while ago a small high-speed engine was installed beside it to help out with the lights, and it exhausts into the same condenser, which is of ample size for both engines. I looked for no trouble, but found on starting the small engine that the vacuum was reduced from 27 to 24 or 25 inches and that the Corliss speeded up. I made no changes at first, thinking that I must be mistaken in regard to the increase in speed, but in less than a week the complaints were made that as soon as the lights were put on the speed became too high.

Now if the speed had slackened ½ turn with the lower vacuum, I should not have been surprised; neither would I if it had remained the same as before, but to have a higher speed with all conditions the same except a lower vacuum is a puzzle to me.

LEIGHTON JOHNSON.

Exeter, N. H.

Feed Water Regulators

In an editorial in the November 14 issue the question is asked, "What is the use of a feed-water regulator?" Ninety men out of one hundred would say, "To keep the water level constant." Well, what is the use of keeping the water level constant? So long as the water is not allowed to get so low as to endanger the heating surface nor so high as to be carried over with the steam, what difference does it make if the water level does vary an inch or two?

To my mind, this question answers itself, for if the water level is constant it will never get so low as to endanger the heating surfaces nor so high as to be carried over with the steam, and this is a point in favor of feed-water regulators. The editorial also states that a feed-water regulator is either always wide open or entirely closed and is alternating in its action, and the editor aims to substantiate this theory by citing a single boiler equipped with a feed-water regulator and saying that with a 100-horsepower boiler with a water surface of 90 square feet evaporating at its rated capacity, 30,000 pounds of water per hour with a boiler-feed capacity of 60,000 pounds per hour the regulator would be closed just one-half the time, at periods from four to eight minutes, according to the nicety of adjustment, and offers this as a very objectionable feature owing to the change of temperature of feed water between periods.

With a single boiler this is true but the editor seems to overlook the fact that most plants which use feed-water regulators are those having several boilers operating in batteries, and it is a well known fact that boilers working in batteries, even though they are of the same size and exactly alike, will not evaporate the same amount of water per hour. Take, for instance, three 100-horsepower boilers; place them in a battery and probably one will be evaporating 30,000 pounds, its rated capacity, and the one on its right may be evaporating only 20,000 pounds, while the one on its left may be evaporating 40,000 pounds, which is above its rated capacity; and probably in 20 minutes these conditions may be reversed.

It has been my experience with feed-water regulators when working on boilers in batteries that the demand for feed water was about constant and in proportion to the combined evaporative capacity of the battery; the feed pumps ran at uniform constant speed and the feed-water temperature was about constant.

H. R. ROCKWELL.

Alton, Ill.

Air Lift Calculations

In the Nov. 21 issue the answer given to the questions by J. A. W. is open to discussion. In the first place, the answer assumes that there is a difference between the pumping and the starting levels of the water in the well. I do not think that there is any ground for such an assumption. I have seen many wells from which 200 gal. per minute could be pumped without lowering the level of the water.

It is generally assumed that a submergence of 60 per cent. is desirable. Such being the case, 130 ft. or the lift equals 40 per cent. Then, the length of pipe to be submerged will be

$$130 \times 1.5 = 195 \textit{ ft.}$$

and the required pressure will be

$$195 \times 0.43 = 84.6 \textit{ lb. per sq.in.}$$

and, adding 3 lb. for friction, the actual working pressure will be 87.6 lb. per square inch.

The answer further states that a 3½-in. pipe would be of satisfactory size for the water pipe. According to the best air-lift practice, this seems rather small. A 4-in. pipe would be better.

S. L. HILLS.

St. Louis, Mo.

Pipe Bends

I was much interested in the editorial in the Dec. 5 issue on "Pipe Bends," but it seems to me that there has been omitted one of the most important features and uses of pipe bends. All steam lines expand more or less under the increased temperature due to the steam, and in the long lines the expansion is an item of considerable importance. With the use of the ordinary fittings for making bends on lines of this character, there is always a danger of fracture of the bends. The use of the long-turn bends as a method for taking up this expansion and transmitting it with the least possible strain forms part of the value of such bends; and in many cases, through the use of loops made of these bends, expansion joints can be entirely avoided with safety, thus eliminating the annoyance often given by joints of this character.

I have found in power plants installed by myself and associates that it pays, as the editorial stated, to use pipe bends; the results in the operation of the plant have been much more successful, there have been far fewer leaks, bad joints and breakages, and the cost has been no greater.

HENRY D. JACKSON.

Boston, Mass.

Inquiries of General Interest

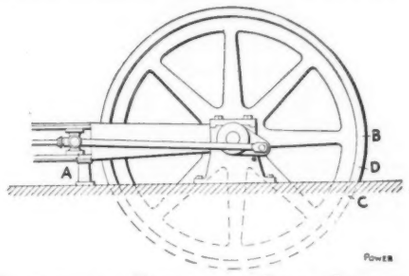
Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

To Find the Dead Center

How is the exact dead center of an engine to be found?

R. W.

Turn the crank just past the center and mark the crosshead and guide, *A*. Also measure from the floor (about 18 in.) to the side of the flywheel rim and make a center punch-mark, *B*. Now turn the crank the other way past the center



PUTTING AN ENGINE ON DEAD CENTER

to bring the marks on the crosshead and guide line in line; then make another mark on the flywheel rim the same distance from the first *C*. Make a permanent center punch-mark on the flywheel rim halfway between the marks on the rim, *D*. If the flywheel is turned until the permanent center punch-mark is the same height from the floor, or 18 in., the engine will be on the exact center.

Horsepower of Compound Engine

How do I find the horsepower of a compound engine?

A. P.

Divide the mean effective pressure in the high-pressure cylinder by the cylinder ratio, add the quotient to the mean effective pressure in the low-pressure cylinder, and proceed to find the horsepower with the diameter of the low-pressure cylinder and the mean effective pressure found.

Lubricating Oil for Air Compressors

What is the best lubricant for air compressors? What are the flash or fire points of ordinary engine and cylinder oils?

J. C.

A suitable cylinder oil is of 550 deg. flash, made up of a high-grade cylinder stock with not less than 20 per cent. by weight of an acidless animal oil; tallow or tallow oil is preferable.

Cylinder oil should not show a flashing point below 525 deg. F., or a burning point below 600 deg. Fahrenheit.

Engine oil should not show a flash point below 325 deg.; it should have a specific gravity of about 29 deg. Baumé.

Steam Lost through Safety Valve

How much will it cost to blow a 3-inch pop safety valve six minutes, reducing the steam pressure from 100 to 97 pounds? Coal costs $3.50 per ton.

E. H. E.

In the Massachusetts safety-valve rules it is assumed that the rise of a 3-inch disk will be 0.09 inch. The quantity of of steam that will flow through an orifice may be approximately calculated by the formula

$$W = \frac{a\,p}{70}$$

in which

W = Pounds of steam discharged per second;
a = Area of the orifice in square inches;
p = Absolute pressure in pounds per square inch.

Taking the average boiler pressure during the period of blowing as 98.5 pounds gage, the weight discharged per second will be

$$\frac{3 \times 3.14 \times 0.09 \times 113.2}{70} = 1.37$$

per second, and for six minutes it will be

$$6 \times 60 \times 1.37 = 493.2 \text{ pounds}$$

The value of the coal burned to make this amount of steam depends on the rate of evaporation. One pound of coal costs 0.175 cent. If nine pounds of water are evaporated per pound of coal burned it will cost $0.175 \times \frac{493.2}{9}$ = 9.57 cents to blow a 3-inch safety valve six minutes when one pound of coal costing $3.50 per ton evaporates nine pounds of water into steam at 98.5 pounds gage pressure.

Boiler Horsepower for Elevators

What boiler horsepower should be allowed for three hydraulic elevators, each having an area of 30 sq.ft. and a speed of 400 ft. per minute?

G. L. P.

To determine the boiler horsepower required depends on the load the elevators will carry, the weight of the elevator minus the counter-balance, the speed and the efficiency. Assume 80 lb. live load per square foot, the weight of the car as 3600 lb., the counterweight as three-quarters of the weight of the car, and the efficiency as 60 per cent. Add the weight of the live load to the unbalanced weight of the car and divide the sum by the product of 1 hp. expressed in foot-pounds and the efficiency. The unbalanced weight of the cars will be

$$3600 \times 3 \times 0.25 = 2700 \text{ lb.}$$

The live weight will be

$$30 \times 80 \times 3 = 3600 \text{ lb.}$$

Substituting these figures in the rule the following result will be obtained for the continued upward movement at full load:

$$\frac{(7200 + 2700)\,400}{0.6 \times 33{,}000} = 200 \text{ hp.}$$

No power is required on the downward movement. The horsepower required per trip would average:

$$\frac{200}{2} = 100 \text{ hp.}$$

Allowing 30 per cent. for slower speed at stops and light loads, about 70 hp. would be required. If a compound pump was used, taking 65 lb. of steam per hour per delivered horsepower, the total steam consumption per hour would be

$$70 \times 65 = 4550 \text{ lb.}$$

Water for Manufacturing Ice

Why is it necessary to use distilled water in manufacturing can ice and ordinary water in manufacturing plate ice?

K. H.

In making can ice the water to be frozen is placed in rectangular cans and is immersed in a refrigerating medium. Freezing takes place on the sides and bottom of the can and the ice increases in thickness until all the water in the can solidifies. Any impurity in the water is driven toward the upper center of the can and is frozen in; hence the necessity of pure water. In making plate ice the water is frozen on both sides of a hollow or cellular metal plate immersed in a tank of ordinary potable water; any impurity is thrown out and settles in the bottom of the tank. The tank can be cleaned by draining off the water. The refrigerant is circulated through the interior of the plate.

Fatal Accident at Chicago

On Dec. 23, at the factory of the Chicago Malleable Castings Co., at Chicago, Ill., the blowoff valve of a 400-hp. vertical water-tube boiler was blown free from its connections, and the escaping steam fatally scalded the fireman and severely injured the engineer. Just before the accident the engineer had opened the valve to blow down the boiler with the fireman standing a few feet away. For some unknown reason the force of the steam blew off the valve and both men were scalded before they could move away. The fireman died the following morning, and the engineer is thought to be out of danger, though at the last report he was still under treatment at the hospital.

Fire from Burst Pipe at Georgetown, Ky.

By the bursting of an ammonia pipe on Dec. 24, the wax plant of the Indian Refining Co., at Georgetown, Ky., was destroyed by fire, resulting in a loss of $125,000.

Tanks of oil and all the machinery in the plant were also destroyed by the fire, which burned for three hours before it was brought under control. Two employees were injured by falling timbers.

BOOKS RECEIVED

QUALITATIVE ANALYSIS; A BRIEF LABORATORY GUIDE. By Arthur E. Hill. Chemical Publishing Co., Easton, Penn. Cloth; 80 pages, 5¼x7 in.; indexed. Price, $1.

PORTLAND CEMENT. By Richard K. Meade. Chemical Publishing Co., Easton, Penn. Second edition. Cloth; 501 pages, 6x9 in.; illustrated; tables; index. Price, $4.50.

NEW PUBLICATION

TESTING OF ENGINES, BOILERS AND AUXILIARY MACHINERY; second edition. By W. W. F. Pullen. Published by the Scientific Publishing Co., Manchester, England. Cloth; 721 pages, 8½x5½ in. Price, 12 shillings 6 pence.

The testing of boilers, engines and other power-plant accessories is treated in a general way, the object being to acquaint the reader with the methods used and the proper handling of the instruments to be employed, so that these may be adapted to meet the needs of each particular case. The theories underlying the operation of many of the instruments are also given.

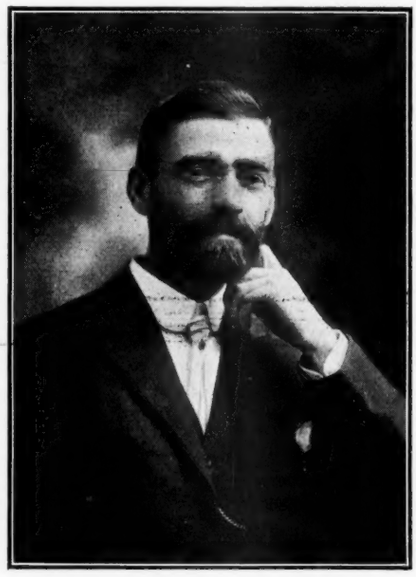
Since the old steam tables of Regnault are still used in many quarters, they have been included, while curves plotted from the more recent steam tables of Marks and Davis are added for optional use. In point of criticism it may be noted, however, that these curves, as well as the entropy charts given in the appendix, are much too small for accurate work.

In spite of the fact that some devices of more or less recent date but of general use in American practice are omitted, the subject is well covered and should prove a handy reference book to the engineer who is called upon to test power-plant apparatus.

OBITUARY

John George Ould died at his home, 1348 Forty-seventh St., Brooklyn, N. Y., on Dec. 21. Mr. Ould had been in poor health for some time. His last appearance was at the annual meeting of the American Society of Mechanical Engineers.

Mr. Ould was born on Apr. 2, 1863, in Falmouth, England. He was graduated



JOHN G. OULD

from the private schools in England and later took a three years' course in the Kensington Science and Art School. He also took a two-year course in the New York Y. M. C. A., two years in Pratt Institute and three years in the Polytechnic Institution of Brooklyn, and had a diploma from the I. C. S. as an electrical engineer.

In his youth he was an apprentice in English shops and then served seven years as a marine engineer on ocean-going vessels. Mr. Ould came to New York in 1890, and for some time was a chief engineer. For 14 years he was superintendent and chief engineer of the Polhemus Memorial Clinic, Brooklyn, N. Y., taking that position in February, 1897.

Mr. Ould was a member of the Philharmonic Society of Brooklyn, an associate member of the American Society of Mechanical Engineers and a corporate member of the Brooklyn Engineers Club. At the time of his death he was a vice-president and commissioner of apprentice training of the Institute of Operating Engineers, as well as being a charter member of the latter.

Mr. Ould was a man of the highest merit in his public and private life and impressed his personality upon everyone he met. He leaves a widow.

Bureau of Mines Appropriations

In the general estimates for appropriations for the fiscal year 1912, which begins July 1, Secretary of the Interior Fisher has recommended the following items for the Bureau of Mines:

For the investigation as to the causes of mine explosions, methods of mining and safety of miners, the appliances best adapted to prevent accidents, the possible improvement of conditions under which mining is carried on, the use of explosives and electricity, the prevention of accidents, and other inquiries and technologic investigations pertinent to the mining industry, $360,000.

For the investigation, analyzing and testing of coals, lignites, etc., belonging to or for the use of the United States, $135,000.

For investigations into the treatment of ores and other mineral substances, with special reference to the prevention of waste in the mining and utilization of important mineral resources, $100,000.

For the investigations of Alaskan coal, with reference to its mining, transportation and utilization, $50,000.

PERSONAL

W. H. McIntyre, formerly fourth vice-president of the Equitable Life Assurance Company, is now first vice-president and general manager of Manning, Maxwell & Moore, Inc., New York City.

For the practice of mechanical and electrical engineering, George C. Thornton and Richard W. Alger, of Chattanooga, Tenn., have formed a partnership in that city. Particular attention will be given to heating and ventilation, plumbing and sanitation and the lighting of modern buildings.

Some time since, Prof. Edward F. Miller, of the Massachusetts Institute of Technology, commented upon the desirability of a temperature entropy chart upon a large scale for classroom use. He was agreeably surprised the other morning by finding upon the wall of the lecture room such a chart, 6 ft. in height by 10 ft. in length, the handiwork of Erwin Haskell Schell, of the class of 1912.

Moments with the Ad. Editor

New Year is the time to look backward—and forward.

This is as it should be—and this year is no exception.

We have a whole lot to be thankful for, notwithstanding the mist and uncertainty that have enveloped business for some time.

Things are never as bad as they seem—the dip is never so deep as it looks.

This is a great big country. No one but the statisticians in Washington realizes the magnitude of our products.

There cannot be far-reaching, unlimited hard times until the man next to the soil is affected. He is prosperous now.

Many of the large concerns of this country are busy. The ship-building industry is booming. Business in Europe is good. In England it is at the high-water mark.

Here, in future, there will be less boom and more straight hustle. There will be less scramble for anything that can be used and more intelligent seeking for the better things.

The great law of supply and demand is always working. Sooner or later we are bound to feel its full effects.

Machinery of all kinds must be used—it is needed to economically manufacture everything used by civilized man.

* * *

The golden rule is in better working order now than ever before.

The extremists at both ends of the social scale are fast losing their grip.

It is dawning on the man behind the machine that money does not make a man an ogre—that an employer has responsibilities and rights.

Capital is more and more realizing that "a man's a man for a' that"; that the rank and file are honest, want to be fair, although at times misled.

But the good fellowship that comes from contact one with another, the exchange of ideas, the putting of oneself in the other fellow's place, all tend to dispel the gray clouds, all work for the brotherhood of man which the New Year season typifies.

Let us forget our troubles during this holiday season, and then each come back to his task with a clearer perspective, an effort that is strong, clean, hopeful and energetic.

All things will be better in 1912. Better manufacturing, better engineering, better selling and better advertising. It 's to be a year of progress.

BUSINESS ITEMS

The Yarnall-Waring Co., 1111 Locust St., Philadelphia, Penn., is putting out a very interesting little magazine called the "Blow-Off," which it will send free to all engineers interested.

The S. K. F. Ball Bearing Co., 50 Church St., New York, has opened an office in Chicago to facilitate the handling of western business. The new office will be in 1505 Heisen Building, and in charge of C. A. Winn.

The Kerr Turbine Co., Wellsville, N. Y., announces the appointment of the following new agents: St. Louis, Walter L. Flower, 312 South Eighth St., and New Orleans, C. E. Grevemberg, 1023 Maison Blanche Building.

The Goulds Manufacturing Co., Seneca Falls, N. Y., has just issued bulletin No. 106, describing the Goulds vacuum and stuff pumps. It is well illustrated and gives complete details of the different sizes in which these pumps are made.

The Deane Steam Pump Co., Holyoke, Mass., in a new bulletin, D-205, gives an extensive discussion of the construction of its triplex power pumps of the vertical, double-acting type. Some nine different styles of these pumps are illustrated and tables of dimensions, capacities, etc., are given of each. The pumps are arranged for belt or gear drive from any power source.

The Robb Engineering Co., Ltd., South Framingham, Mass., has recently sold 48-in. horizontal return-tubular boilers to the Syracuse Supply Co., Syracuse, N. Y.; John G. Belding, Northampton, Mass.; Charles T. Holmes, Plymouth, Mass.; and 72-in. boilers of the same type to the Consolidation Coal Co., Portsmouth, N. H., and Pierce & Cox, Boston, Mass.

The Mount Vernon Straw Board Co., Mount Vernon, Ind., after using two Vulcan soot cleaners for about six months, has placed a repeat order for four more cleaners with G. L. Simonds & Co., 801 Steinway Building, Chicago, Ill. This will equip its entire battery of six boilers with the Vulcan soot cleaners and by the installation of this cleaner the company says it will be able to cut out one boiler entirely, thereby saving six to eight tons of coal per day.

The Scientific Belt Fastener Co., of Fort Wayne, Ind., is placing on the market a new device for joining the ends of all kinds of belts. It is called the X-L-ALL belt fastener, and consists of a piece of steel wire formed in such a manner that it makes what is said to be a very strong and elastic joint. The company is anxious to get in touch with all mill-supply jobbers with a view to having them take the agency for this belt fastener, and will be glad to send a free sample of the fastener upon request.

The Haverhill Electric Co., of Haverhill, Mass., has added to its turbine equipment by ordering from the Westinghouse Machine Co. a 2500-kw. steam turbine generator with a Westinghouse Le Blanc condenser. It will also equip its boiler plant with Roney automatic stokers. The turbine will operate at 150 lb. steam pressure with 100 deg. superheat, and the condenser is designed to produce 28 in. of vacuum. This equipment will be used to supplement the existing equipment of this company, which consists of two Westinghouse turbine units of 1000 kw. capacity.

The General Electric Co., Schenectady, N. Y., advises that C. W. Stone has been appointed manager of the lighting department of the General Electric Co. to succeed C. D. Haskins, deceased.

The Atlantic Hygienic Ice Co., of Brooklyn, N. Y., recently purchased a 14-in. Swartwout horizontal oil separator, made by the Ohio Blower Co., Cleveland, Ohio. This company reports other recent sales of Swartwout products as follows: Chattanooga Steam Laundry Co., Chattanooga, Tenn., one 3½-in. horizontal oil separator; Jones & Laughlin Steel Co., Pittsburg, Penn., one 10-in. galvanized iron exhaust head; John Bouchard & Son Co., Nashville, Tenn.; one 8-in. horizontal oil separator; North Shore Electric Co., Blue Island, Ill.; one 8-in. horizontal oil separator; W. K. Mitchell & Co., Philadelphia, Penn., one 4-in. vertical high-pressure steam separator; Wisconsin Steel Co., Nashwauk, Minn., one 6-in. vertical high-pressure steam separator; F. W. Lamb Co., Chicago, Ill., one 10-in. cast-iron exhaust head, one 5-in. cast-iron exhaust head; F. W. F. Carlisle Co., Saginaw, Mich., one 6-in. horizontal oil separator; Edible Products Co., Bayonne, N. J., one 6-in. horizontal oil separator; Virginia Carolina Chemical Co., Birmingham, Ala., two 5-in. cast-iron exhaust head, two 3-in. vertical steam separators; Standard Steel Car Co., Butler, Penn., one 12-in. cast-iron exhaust head; Keystone Rubber Works Co., Erie, Penn., one 7-in. cast-iron exhaust head, one 6-in. vertical steam separator.

ENGINEERS WANTED

Under this head are published, without charge, advertisements of actual vacancies in power plants for operating engineers and assistant engineers. For the guidance of applicants for advertised positions, the advertisements must contain particulars to show the class of service demanded and the wages paid. Employers who desire to advertise under this head are requested to write for a blank form of application.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

AGENTS WANTED—To sell popular steam specialty; commission basis only. Address "Rekcutaw, Post Office Box 363, New York.

SALESMAN — Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," Power.

AGENTS for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

FIRST-CLASS tool maker with inventive ideas and accustomed to small tool work for iron and brass valves and fittings. Box 553, Power.

THE VULCAN SOOT CLEANER offers an exceptional opportunity for power specialty salesman Address G. L. Simonds & Co., 802 Steinway Bldg., Chicago, Ill.

MASTER MECHANIC wanted for pulp mill; used to construction and machinery installation; state age, experience and wages expected; application treated strictly confidential. Box 552, Power.

AGENTS—To sell lubricating oils, belts, hose, paint and varnish, for power machinery, to factories, mills, auto owners, stores; exclusive territory; oil experience unnecessary. Manufacturers Oil & Grease Co., Cleveland, Ohio.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

POSITION WANTED by a single man, 28 years old, with mining company who require service of an engineer to take charge boilers, Corliss and high speed engines, dynamos and motors and air compressors. Address Box 554, Power.

TECHNICAL GRADUATE in mechanical engineering, 24 years old, desires position where there is a good opportunity for experience and advancement; have had some experience in shop and drafting room; references. Box 548, Power.

AFTER JAN. 1 employment wanted either temporary or permanent, by mechanical engineer, trained and with actual experience in most all branches of the business, as practical machinist and operating engineer, as erecting and consulting engineer, as draftsman and shop foreman, as salesman and office man handling correspondence, etc.; have made a study of power house economies; personal interview or correspondence solicited; gilt-edge references as to integrity and reliability; would represent engine, boiler or power-house equipment manufacturer as resident or traveling engineer in this section. Address "Mechanical Engineer," Room 1533, Exchange Bldg., Memphis, Tenn.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

PATENTS—C. L. Parker, Patent Attorney, ex-examiner Patent Office, 904 G St., Washington, D. C. Write for Inventor's Handbook.

PATENTS—Herbert Jenner, patent attorney and mechanical expert, 608 F St., Washington, D. C. I make a free search and report if patent can be had and the exact cost.

ENGINEERS AND FIREMEN—Send 10 cents in stamps for a 40-page pamphlet containing a list of questions asked by an examining board of engineers. Stromberg Publishing Co., 2703 Cass Avenue, St. Louis, Mo.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. C. P. Monash, 1417 W. Jackson Blvd., Chicago, Ill.

MARKET YOUR INVENTION—A manufacturing firm of high commercial standing, with unexcelled manufacturing facilities, and with over sixty road salesmen, desires to take on an additional line of power plant specialties; will consider any invention that has real merit, or will confer with men interested in any mechanical device, patented or otherwise; will manufacture on royalty or purchase direct; may also utilize services of applicant. Address Box 551, Power.

ANNUAL MEETING of the stockholders of the Hill Publishing Company, for the election of directors for the ensuing year and for the transaction of such other business as may properly come before the meeting, will be held at the offices of the company, in the Hallenbeck Building, 497-505 Pearl St., Borough of Manhattan, New York City, N. Y., on Tuesday, January 30, 1912, at 12 o'clock noon.

Dated, New York City, Dec. 19, 1911.

Robert McKean, Secretary.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—Five Corliss vertical water leg, and sixteen Manning vertical type boilers. J. & P. Coats, Ltd., Pawtucket, R. I.

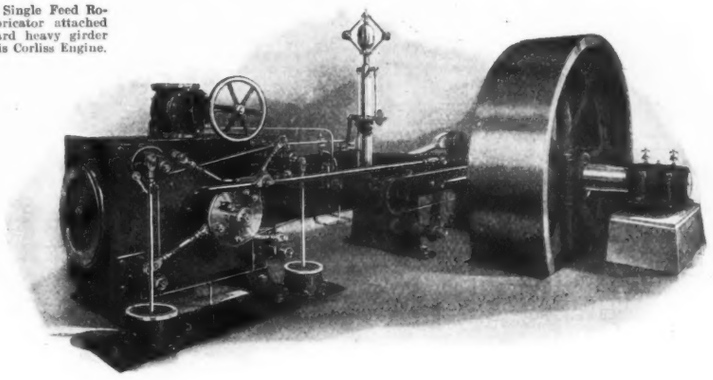
ONE SINGLE CYLINDER, 66 horsepower gas engine and producer; made by the Power & Mining Machry. Co., Avery Scale Co., North Milwaukee, Wis.

8x10 SKINNER ENGINE, direct connected to 30-kilowatt generator, and 8x10 Allfree engine, direct connected to 20-kilowatt generator . Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

ONE 100-HP. KINGSFORD marine boiler, corrugated tube, used only 18 months, guaranteed to pass inspection; one Geary water tube boiler, 100-hp., in first-class condition. G. J. Burrer & Sons, Sunbury, Ohio.

IDEAL, simple engine, 14x14, 125 horsepower at 100 pounds pressure; rebuilt with new Chuse shaft, new piston and valve; in first-class condition; larger engine installed, reason for selling. F. A. Heermans, city clerk, Mattoon, Ill.

Three Pint Single Feed Rochester Lubricator attached to a standard heavy girder frame Harris Corliss Engine.



Not Affected By Temperature

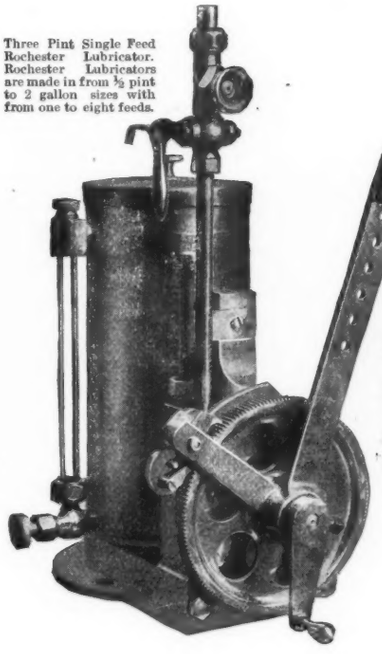
ROCHESTER
AUTOMATIC
LUBRICATORS

¶ One of the most important and distinctive features of our Rochester Automatic Lubricators is that they are not affected by temperature, pressure or vacuum. They are at all times entirely reliable and positive in operation. Where more than one feed is used, each feed can be regulated independently. Working parts are made of steel and principal working parts are enclosed and protected from dirt, grit, etc. All bearings case hardened.

To responsible parties not familiar with the merits of our Lubricators, we will be pleased to send one on 30 days' trial at our risk and expense, and guarantee all we claim for them.

SEND FOR A LUBRICATOR ON TRIAL. ALSO FOR COMPLETELY ILLUSTRATED CATALOG.

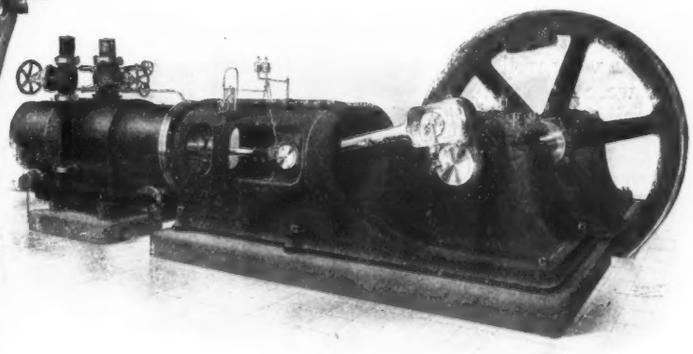
Three Pint Single Feed Rochester Lubricator. Rochester Lubricators are made in from ½ pint to 2 gallon sizes with from one to eight feeds.



Greene, Tweed & Co.

109 Duane Street **New York**

English Agents: Jenkins Bros., Ltd., 95 Queen Victoria Street, London, E. C., England.



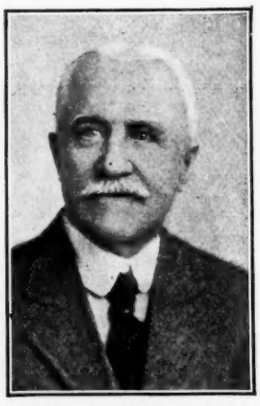
Three Pint Single Feed Rochester Lubricator attached to an Arctic Horizontal Ammonia Compressor.

The "Eureka" Square Deal

Published every other week in the Interests of Honesty in the Packing Business.

By James L. Robertson.

The Spirit of the New Year



JAMES L. ROBERTSON

This is the New Year season. The best New Year advertising is that which has the most genuine New Year spirit in it.

I wish that I were writer enough to put into this New Year advertisement the very spirit of 1912.

If I fail to do so it will not be because I do not understand and comprehend it but because I cannot express it.

I want you to know that I believe that the advertiser has become too tremendously an important figure in modern life not to have some moral responsibilities. He does not hanker after them of course. But he has them just as do all those who in any way catch the eye and ear of the public.

And because I believe that I have done more in the past year than to try to sell Eureka Packing—I have tried to suppress the graft condition that I know is hurting the engineering profession.

For this I have been accused of most crimes in the penal code and praised for most virtues.

One would think to listen to the first that I had an undying antipathy for the engineers—that I was their enemy.

How far from the truth that is!

For years I have dealt with engineers—and for years those dealings have been a pleasure and satisfaction to me and, I hope to them.

I have taken a real interest in my business and have got something more than money profit out of it. Could I very well do that if I were dealing with men who were distasteful to me, who were in any sense enemies?

I doubt it. The interest and fun a man gets out of business depends almost entirely upon the kind of public he serves—and engineers are my public.

For them I have more than a little respect—I have a real admiration.

I admire men who carry a heap of responsibilities and carry them lightly.

I admire men who have pulled themselves up from a slice bar to the top of the heap by their own bootstraps.

And by the same token, I've got so little respect for the crook who by insidious and underhanded methods tries to put these same men into his cash-box that I come out in print and tell him what his right title is to his face.

Those crooks are the real enemies of the engineer and the sooner it's realized the sooner things will mend.

Times are on the mend now. And in that thought is the spirit of the New Year. To better conditions in 1912! To purge the profession of its grafters and manufacturers of their bribery artists. To look forward and to see a newer and better and more efficient engineering profession. To gain by *knowledge* the material things that only knowledge will permanently give us.

That should be the aim of every maker of power plant supplies and every buyer of them.

We've got a clean slate before us. What shall be the writing on it?

Are we to disfigure it with Graft and Dishonesty or are we to write Square Methods and Self-Respect on its new surface?

Are we to continue to let a few men put the Stigma of Graft upon all of their fellow-engineers or are we going to stamp the evil out?

Are you willing to have the privilege supply-buying filched from you because some few have proved unworthy the trust?

These are the questions that face us as this old year totters its feeble way into history and as we stand upon its threshold these are the questions that 1912 demands an answer to.

Gum Core

If we get the spirit of the new, clean year under our belts and into our hearts and hands strong enough, our answers will make for a new and better era in engineering.

Eureka Packing—39 Varieties—Have You A Catalog?

Eureka Packing Co. (Jas. L. Robertson, President.) 76-78 Murray St., New York